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Chicago Freight Interchange Yard

The railway traffic of Chicago includes a large proportion of through freight, and as Chicago is a terminal for all the railways entering it there is a great amount of interchange service in transferring through cars from one road to another. The freight yards of the various 25 trunk railways are widely scattered, so that the transfer of cars forms a vast and complicated system, with long hauls in many cases, involving much loss of time in the through movements of cars. In addition, the handling of these cars in the railway yards increases the congestion of the crowded city terminals, since each car has to be handled in the inbound yard of one road and the outbound yard of another road. This complication of the railway traffic at Chicago was outlined in ENGINEERING NEWS, Jan. 2, 1902, and May 9, 1912.

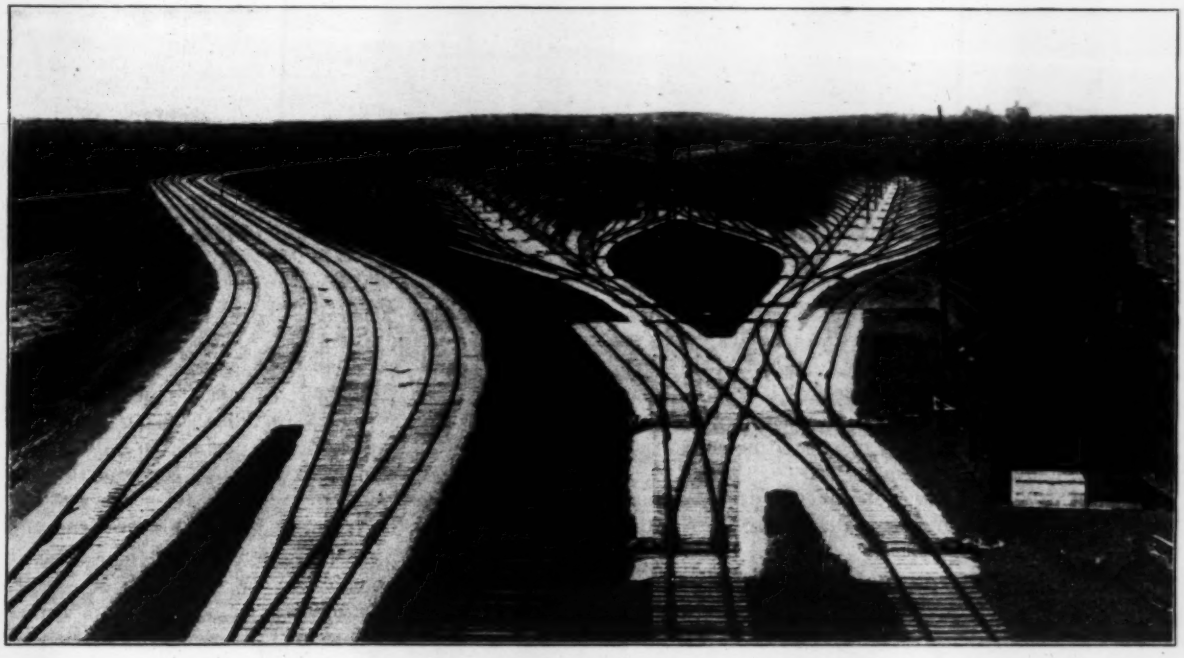


FIG. 1. ENTRANCE TO THE WESTBOUND CLASSIFICATION YARD

(This view is from the bridge at the summit of the switching hump. At the left are the four approach tracks to the two eastbound hump tracks. At the right are the two westbound hump tracks, with connections to the classification ladders. The single track in the middle is for the motor car bringing back the car-riders to the hump)

About 1890 the late A. B. Stickney, then president of the Chicago Great Western Ry., conceived the idea of establishing a general interchange yard in the outskirts of the city, where all through cars would be received, transferred and forwarded. In this way the work would be concentrated and systematized, while the local or city yards would be relieved from the handling of through cars. A novel switching scheme was proposed by Mr. Stickney for this interchange yard. There were to be circular tracks, with four outside groups of yards, tangent to the circle. Each group was to consist of five parallel yards, making 20 in all, one for each railway. Cars would be shifted from one group to another by passing around the circular track (see ENGINEERING NEWS, Feb. 8, 1890, and Sept. 8, 1892).

The Chicago Union Transfer Co. was organized and a site was secured (which is the site of the new interchange yard described in what follows), but owing to lack of support by the railways and to the unfavorable financial conditions at the time, the project was never carried into operation. It will be evident that the success of such a system depends on the coöperation of a number of roads, for it would be of little benefit to handle the traffic of three or four lines in this way while a dozen other lines adhered to the former individual system of interchange.

In 1902 the project was taken up by other interests, and a very extensive yard was built at the Stickney site by a private concern, the Chicago Transfer & Clearing Co. The yard was planned on the usual longitudinal arrangement of tracks, and provided for gravity switching. An elaborate electro-pneumatic plant was installed for oper-

ating the switches of the classification tracks from a tower on the switching hump. The yard and its operation were described in ENGINEERING NEWS, Jan. 2, 1902. The handling of local freight cars between this yard and the Chicago city yards of the several railways was to be an auxiliary part of the project. This private project also failed to receive the support of the railways, and the yard was never put into service. The company then devoted itself to the industrial development of its property and later established a manufacturing and industrial district known as Clearing.

With the continued increase of traffic and congestion of city terminals, and with the demands of the city for reduction rather than increase of space occupied by terminals, the railways began to consider for themselves the means of improving the conditions. In 1912 about a dozen of the trunk lines combined to form an organization to lease and operate the Clearing yard and the Belt Division of the Chicago & Western Indiana R.R. These two facilities constitute a great interchange system, with connections to all the railways entering Chicago. This step was described in ENGINEERING NEWS, May 9, 1912. The work of reconstructing and enlarging the yard is now practically completed. It is not only the largest freight yard in the world but the only one operating such a comprehensive interchange system.

In this third design the system of longitudinal movements and the use of gravity switching for classification have been retained, but the trackage and facilities have been increased materially, while locomotive- and car-repair shops have been added. The yard as it now stands provides standing room for about 8000 cars (exclusive of repair tracks) and for the handling and forwarding of about 10,000 cars daily.

The general layout is shown in Figs. 2 and 3. The site is south of 65th St., between Crawford and Harlem Aves. Only one street (Cicero Ave.) crosses the yard, and this is carried by a viaduct of plate-girder spans on concrete piers. It will be seen that duplicate facilities are provided for movements in both directions, the classification for both groups being effected by gravity movements from the switching hump at the middle of the yard. (See profile in Fig. 4.)

Trains for the north and west (brought in by road or transfer engines) will enter at the east and go to the receiving yard. There the engine will be cut off and sent to the adjacent departure yard to take an east- or southbound train out of the yard. After the train in the receiving yard is marked and the switching list prepared for the switchmen in the operating tower, a yard engine will push the train to the summit of the hump, beyond which each car (or cut of cars) will run by gravity onto the tracks of the classification yard. The cars on these tracks are made up into trains in the departure yard, ready for the engines. The train may be taken by a road engine and started directly to its destination, or taken by a transfer engine to the main outbound yard of the railway over which it is to travel. In the same way trains of through cars from the north and west, destined for points east and south, will enter the receiving yard at the west end and will be worked through to the classification and departure yards at the east end.

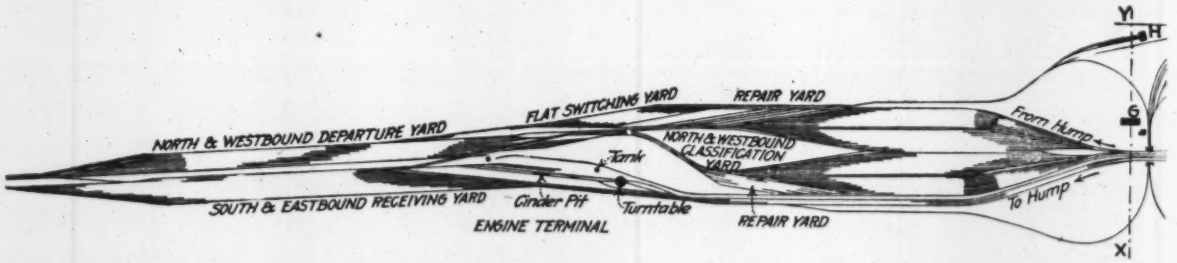


FIG. 2. WEST SIDE OF FREIGHT INTERCHANGE YARD OF THE CHICAGO & WESTERN INDIANA R.R. AT CLEARING (CHICAGO)

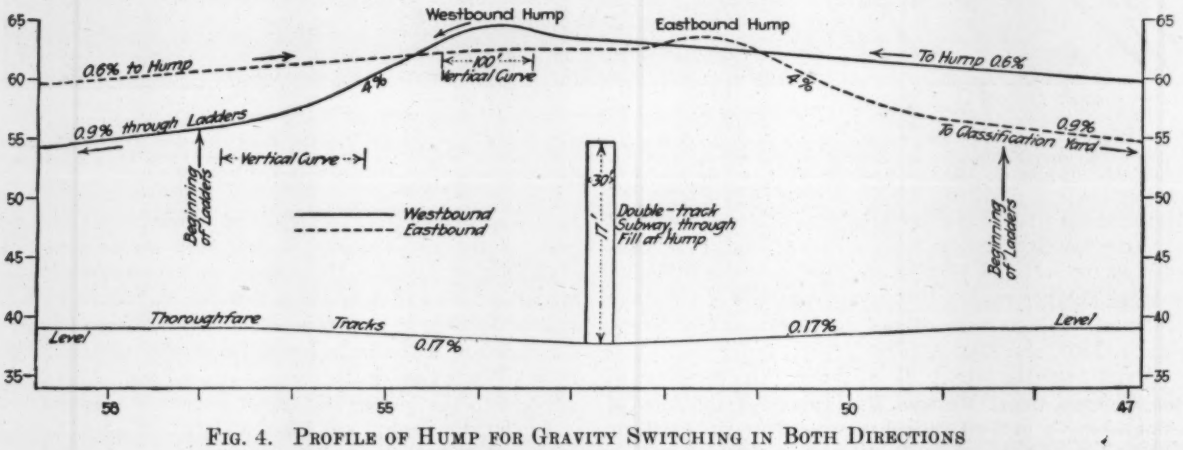


FIG. 4. PROFILE OF HUMP FOR GRAVITY SWITCHING IN BOTH DIRECTIONS

Auxiliary to the main system of tracks are repair, bad-order and thoroughfare tracks (the last-mentioned pass-

ing both around and under the hump at the yard level). In this way all internal movements of both cars and engines can be made without passing over the hump and without interfering with the regular flow of traffic through the yard.

Each classification yard has two repair yards (one for each section). These are for light repairs only, heavy repairs being done at the shops near the center of the yard. Running around each side of each classification yard is a bad-order track. Outside of this is a track for a gasoline or electric motor car, which will carry back to the hump the car riders or brakemen who ride the cars into the classification tracks and control them by the brakes.

Fig. 1 is a view looking west into the classification yard from the bridge at the summit of the hump. It will be noted that stone ballast is used on the ladders and approach tracks, and that three rows of lamps are used for the illumination of the classification yard.

For local traffic of the Clearing industries and for certain classes of traffic which it is not desirable to send over the hump, a special group of tracks for flat switching is provided near each end of the yard.

The gravity hump will have four tracks, so that two trains in each direction can be handled simultaneously, each classification yard being so arranged or subdivided as to permit of being operated as two separate units. Each hump track is provided with two approach tracks. This permits a second train to be pushed nearly to the summit, ready for classifying as soon as the first train has been pushed over and its engine has cleared the switch in returning for another train.

For gravity switching, an approach track of 0.6 per cent. grade ascends from the receiving yard, and at the hump the elevation is raised about one foot by vertical curves of 1500 ft. radius in order to bring the cars together and make the couplers slack so that they can be released readily. This grade ends in a vertical curve of 1500 ft. radius over the hump, beyond which is a starting grade of 4 per cent. 50 ft. long. This connects by a vertical curve of 5000 ft. radius with the classification ladder, which has a grade of 0.9 per cent., while the body tracks in the classification yard have a grade of 0.4 per cent. The profile is shown in Fig. 4.

The hump for westbound switching is 1 ft. higher than the other in order to compensate for prevailing winds by giving a greater length of the 4-per cent. starting grade. It is probable also that changes in the details of the humps will be required from time to time to meet the varying climatic conditions of summer and winter. It is estimated that 10,000 cars per day can be classified.

The yard has about 150 mi. of track in all, laid with 75- and 80-lb. rails. Tie-plates are used at turnouts and on curves. The body tracks are spaced 13 ft. c. to c. and 16 ft. from running tracks. There are about 800 turnouts, having 15-ft. switch rails and mainly No. 9 frogs. The frogs and guard-rails in the more important tracks are of cast manganese steel. No slip switches are used.

The switches of the classification ladder are controlled by operators in a tower on a bridge which spans the tracks at the summit of the hump, (see Fig. 1). The tower has two electro-pneumatic push-button machines, one for each direction, each machine operating 65 switches by means of the push-buttons. The operators also operate semaphore signals mounted on the bridge and on the approach tracks, to govern movements over the hump. This switch and signal-control apparatus has been installed by the Union Switch & Signal Co. At each ladder switch is a dwarf semaphore signal with lamp showing green and red for closed and open positions.

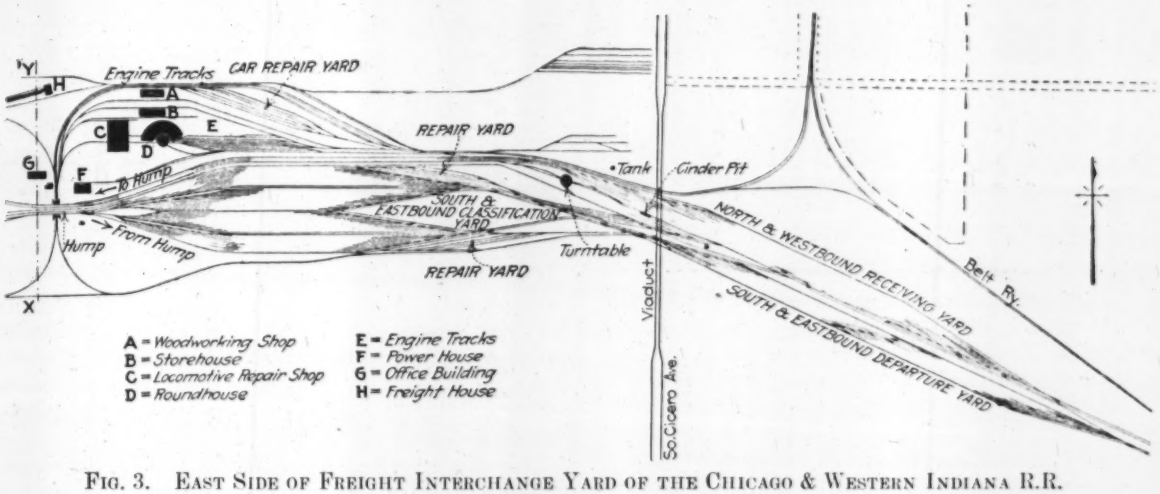


FIG. 3. EAST SIDE OF FREIGHT INTERCHANGE YARD OF THE CHICAGO & WESTERN INDIANA R.R. AT CLEARING (CHICAGO)

Alongside of the switching hump, with the switch and signal tower and bridge at the summit and the double-track subway for thoroughfare tracks passing beneath it, has been erected the new brick office building, which will serve not only for the yard work but for the division offices of this section of the Chicago & Western Indiana R.R.

Engine facilities are provided at each end of the yard, so that road or transfer engines do not have to run through the yard (Fig. 1). At present only a cinder pit, turntable and a 100,000-gal. tank with water crane are provided, with tracks on which the engines may stand while waiting for return loads. Later a coaling station may be provided at each end. For the yard engines there are separate facilities furnished adjacent to the shops near the middle of the yard. These include a 20-stall roundhouse, 90-ft. electrically operated turntable, 500-ton coaling station and sand house (serving four tracks),

100,000-gal. water tank and four water columns, a three-track cinder pit, and eight tracks for placing engines not in service and not needing to go to the roundhouse.

The shops include the following: Repair shop (for engines and heavy car repairs), 293x172 ft.; woodworking shop, 200x60 ft.; storehouse, 230x42 ft.; six-track car-repair yard and three-track caboose yard. Industrial tracks of standard gage serve the repair yard. Electric current for yard and shop lighting, for power purposes and for the switch and signal plant is supplied from a steam-driven power station near the shops. This also supplies compressed-air and steam for shop use, for the signal plant and for heating. Compressed air for testing brakes in the departure yards is provided by electrically driven compressors.

A local freight house for less-than-carload freight is provided for the accommodation of the Clearing district. The building is 32x65 ft., at the end of a 14-ft. platform 375 ft. long, between two stub tracks.

The present capacity of the yard is shown in the accompanying table, together with its capacity when enlarged to the full size as planned.

All the design and construction work has been under the direction of E. H. Lee, vice-president and Chief Engineer of the Chicago & Western Indiana R.R., acting with an engineers' committee representing the twelve trunk lines which are joint owners of the project. F. E. Morrow, Principal Assistant Engineer, has had direct charge of the plans and design, and V. R. Walling, First Assistant Engineer, has been in direct charge of construction.

FREIGHT INTERCHANGE YARD AT CLEARING, ILL.; CHICAGO & WESTERN INDIANA R.R.
(Car facilities for movements in each direction)

	Present	Future
Receiving yard, number of tracks	16	30
Number of cars (70 per track)	1,120	2,100
Hump tracks	4	4
Classification yard, number of tracks	52	52
Number of cars (45 per track)	2,340	2,340
Departure yard, number of tracks	12	21
Number of cars (70 per track)	840	1,470
Flat switching yard, number of tracks	9	....
Number of cars	176	....
Car-repair yards (four), number of tracks	4	....
Number of cars	240	....
Capacity for cars in each direction	4,470	6,080
Total capacity, exclusive of repair tracks	8,940	12,160

Economical Highway Design

By W. G. Harger*

SYNOPSIS—This is a supplement to two previous articles in Engineering News *by the same author (issues of July 13, 1911, and Dec. 4, 1913). It gives data on the first cost and maintenance of 600 miles of New York State roads in the vicinity of Rochester and Buffalo, together with the author's conclusions therefrom. Opportunity for economy in highway design is discussed under grading, surfacing, foundation, depth of top course and width of paving.*

The basic idea of a road system is to serve the public, and the more miles of road improved and kept in shape, the more service given. The amount of money that can be obtained for road work has a limit, and the available funds should be made to cover as great a mileage as possible, consistent with economical results. In an effort to help solve this problem the following data have been collected, based on experience with approximately 600 miles of improved roads during a period of six years.

Economy in Grading

Grading is the most permanent feature in road improvement, and for that reason there should be no false economy in this part of the expenditure. In establishing the profile no economy should be attempted by exceeding the ruling grades; there is no object, however, in reducing a natural grade of, say, 4% to 3%, provided the adopted ruling grade is 5%. The economy of profile design is limited to the intermediate grades, and these grades should follow the natural profile as closely as possible.

The selection of the cross-section affords a chance for economy. A wide cross-section with deep ditches requires more grading than a narrower cross-section with shallow ditches. A commonly used cross-section is one 32 ft. between ditches, which are 18 to 24 in. below crown grade. For most places a 26-ft. width with 12- to 14-in. ditches is satisfactory, and will save from $300 to $400 per mile. My experience indicates that a deep open ditch has very little effect in drawing off ground water. Where ground water is encountered underdrains should be used.

For the greater part of country highways the grade line can be placed at any desired elevation without damage to abutting property, and it is desirable under such conditions to have the earthwork balance. The proper ratio of cut to fill is open to argument. That in common use, however, 1.35, has sometimes caused a large loss, to my knowledge. In general, the following ratios are more nearly correct:

Light skimming work, large amount of sod to be wasted	1.35
Light skimming work, considerable sod to be wasted	1.30
Light skimming work, not much sod to be wasted	1.25
Medium work, not much sod to be wasted	1.20
Heavy work	1.15

By the use of a proper balance, fluctuating section, and well-laid profile $600 to $900 per mile can be saved over the often careless designs.

Types of Road Surfacing

The roads under discussion may be classified according to traffic.

Class I—Main trunk roads for 5 to 20 miles out of cities of 50,000 or more inhabitants and the roads in the business sections of villages, which carry the concentrated garden-truck traffic of a large area and are subjected to continuous motor-truck and touring-car traffic.

Class II—Main through automobile routes at greater distances from cities, which have a large touring-car traffic and a medium-heavy farm-produce traffic.

Class III—Secondary feeder and cross roads having a medium-heavy farm traffic and a light automobile traffic.

Class IV—Pleasure-vehicle roads and scenic routes that have a heavy touring-car and light steel-tire traffic.

*No. 16 Hinsdale St., Rochester, N. Y.

For these classes the following types of construction have proved the most economical in the long run:

Class I Traffic—Brick, asphalt block, or asphaltic concrete on a concrete base, at a first cost of $20,000 to $28,000 per mile.

Class II Traffic—Bituminous macadam, waterbound macadam with bituminous flush coats, "Amiesite," and in the near future, probably, small brick cubes at a first cost of $12,000 to $14,000 per mile.

Class III Traffic—Waterbound macadam treated with calcium chloride or light road oil or tar, at a first cost of $8000 to $11,000 per mile.

Class IV Traffic—Bituminous macadam, concrete, waterbound macadam with bituminous flush coats, "Amiesite," and "Rocmac," at a first cost of $10,000 to $15,000 per mile.

These selections are based on satisfactory performance under traffic and moderate maintenance and renewal costs.

Maintenance and Renewal Costs

In order to have a uniform basis of comparison of the maintenance costs and of the cost of renewal at the end of the pavement life, the figures given below are compiled for 16-ft. widths of macadam and brick.

For 16-Ft. Waterbound Macadam; Class III Traffic—The life of the top course is 4 to 8 years; say 6 years under the following maintenance:

TABLE OF COST OF MAINTAINING WATERBOUND MACADAM

Yearly patrol, including materials for minor repairs and painting guard-rail, at $200 per mile per year..	$1200
Calcium chloride, first and seventh years at $125 per mile per year.....	250
Light cold oiling, second year.....	250
Heavier cold oiling, third year.....	500
Binder grade bituminous flush coat, fifth year.....	1000
Resurfacing, seventh year.....	3500
Seven-year total.....	$6700
Cost per mile per year of maintenance and renewal...	$1000
Cost per mile per year of maintenance.....	$500

For 16-Ft. Bituminous Macadam; Classes II and IV Traffic—The life of the top course is 5 to 10 years; say 7 years as an average.

TABLE OF COST OF MAINTAINING BITUMINOUS MACADAM

Yearly patrol, including minor repairs, at $200 per mile per year.....	$1400
Light oiling, third year.....	250
Light oiling, fourth year.....	250
Binder-grade bituminous flush coat, fifth year.....	1000
Light tar coat, seventh year.....	250
Resurfacing, eighth year.....	6000
Eight-year total.....	$9150
Cost per mile per year of maintenance and renewal...	$1100
Cost per mile per year of maintenance.....	$500

For 16-Ft. Brick Pavement; Class I Traffic—The probable life is based on medium traffic in Rochester city streets and is 10 to 25 years; say 18 years as an average.

TABLE OF COST OF MAINTAINING BRICK PAVEMENT

Yearly patrol and minor repairs, at $100 per mile per year.....	$1,800
Renewal of surface and edging, 18 years.....	15,000
Eighteen-year total.....	$16,800
Cost per mile per year of maintenance and renewal.	$900

The New York State system of maintenance on these roads consists of a one-man patrol taking care of culverts, shoulders and small holes and ruts, with gang work, either day-labor or contract, for the larger items of oiling, etc. This system is not highly efficient, as the executive heads are changed on an average of once in two years for partisan reasons and the money is not available early enough in the season to be used to the best advantage.

The figures given are based on roads largely within short radii of Rochester and Buffalo, cities of 200,000 and 450,000 people respectively. The average life of these roads is somewhat less than it will be when the rest of the rural roads in the system are completed. By reducing the work of the one-man patrol, increasing the gang work and allowing for the natural reduction of the average maintenance cost due to the large mileage of narrow strictly rural roads to be built in completing the 11,000 miles of the New York State system, the average cost of maintenance and renewal for the entire completed system should not exceed $800 per mile per year.

The maintenance and renewal cost per year of all the types of road surfacing is approximately the same, provided each type is used under the class of traffic stipulated. Economy in the selection of the kind of pavement to be used in any special case will, therefore, depend on selecting the pavement of lowest first cost from the different types suitable for the class of traffic which the road is to serve.

TABULATION OF YEARLY COST

Type	Class of Traffic	First Cost	5% Interest	Yearly Maintenance and Renewal	Total Yearly Cost
16-ft. brick pavement.	I	$26,000	$1300	$900	$2200
16-ft. bituminous macadam	II & IV	13,000	650	1100	1750
16-ft. waterbound macadam	III	11,000	550	1000	1550

Economy in Foundation for Macadam Roads

Sufficient thickness of the foundation to suit the various soil conditions should never be sacrificed to reduce first cost. Saving in foundation should be attained by, and limited to, the use of the cheapest local materials. Satisfactory foundations can be built of many materials not suitable for top courses; and in general it is cheaper to use a material that does not require crushing.

Stony gravel makes a satisfactory foundation for Classes II, III and IV traffic; the depth can be easily varied to fit any soil condition. Uncrushed fieldstone hardheads filled with gravel or crushed stone make a cheap and effective foundation for heavy soils, but are not recommended for good foundation soils, as it is difficult to construct a smooth riding top course over them. For fairly firm foundation soils local crushed stone is the cheapest and best, provided good gravel is not available, and is to be preferred for Class II traffic even if gravel can be obtained.

Economy in Depths of Top Course

As the top course is relatively more expensive than the foundation course, a good design calls for the least thickness of top that can be readily constructed and that will act well under traffic. For waterbound macadam this thickness has been set by experience at 3 in. For bituminous macadam by the penetration method, the usual practice is 3 in., using from 1.75 to 2 gal. of bitumen per sq.yd. My experience, however, leads me to recommend a 2½-in. depth with 1.6 gal. of bitumen per sq.yd. This saves about $400 per mile for a 16-ft. road, and has proved as satisfactory as the 3-in. top.

For sheet asphalt I recommend 1 in. of binder and 2 in. of asphalt, although 2 in. of asphalt without binder has been fairly satisfactory. A 1½-in. thickness of asphalt without binder is too thin.

The depth of a standard paving brick, 4 in., adds materially in freight and to the cost of the pavement. Monroe County has been experimenting with 2½-in. vitrified shale cubes, and the probabilities are that in the near future they will be used on a considerable mileage of Class I traffic, at a saving of approximately $3500 per mile over the standard brick pavement 16 ft. wide.

Economy in Widths of Paving

The costs per foot width per mile for different pavements are approximately as follows:

Type	Cost per Foot Width per Mile
Brick	$1200
Asphalt	1100
Bituminous macadam	580
Waterbound macadam	500
Concrete	600

The usual practice for Classes I, II and IV traffic has been a 16-ft. width, and for Class III traffic 12, 14, and 16 ft., with no special shoulder treatment. The best practice at present calls for a minimum width of 15 to 16 ft. for Classes I and II traffic, with or without shoulder treatment, depending on the natural soil. The usual widths of 10 to 16 ft. for Classes III and IV traffic have crusher run or gravel shoulders for the 10- and 12-ft. widths.

The 10-ft. width with stone shoulder has been satisfactory for Class III traffic and saves approximately $2500 per mile over a 16-ft. road, of the usual design.

Relative Costs of Different Items in Road Construction

The tabulation below is based on the average costs per mile for 200 miles of 16-ft. state roads in this locality and shows the relative cost and percentages of permanent and temporary features.

TABLE OF RELATIVE COSTS OF DIFFERENT PAVEMENT ITEMS

	Brick		Bit. Macadam		Water Macadam	
	Cost per Mile	Per Cent. of Total Cost	Cost per Mile	Per Cent. of Total Cost	Cost per Mile	Per Cent. of Total Cost
Excavation	$2200	9.0	$1900	15.9	$1900	18.3
Drainage structures	700	2.8	700	5.3	700	6.7
Foundation courses	6300	25.9	3300	27.0	3300	31.7
Surfacing and edging	14700	60.1	5900	47.5	4000	38.5
Minor points	500	2.2	500	4.3	500	4.8
Total of permanent features	9200	37.7	5900	48.2	5900	56.7
Total of temporary features	15200	62.3	6400	51.8	4500	43.3
Probable life of temporary features	10 to 25 yr.		5 to 10 yr.		5 to 10 yr.	

I have given no cost data on concrete roads, as our experience with them has been unfortunate and inconclusive. In my judgment it is not a type than can be economically used in many cases, except for Class IV traffic.

General Summary

Justifiable economy in grading is limited to the treatment of intermediate grades and to variations in cross-section to fit local conditions.

Economy in foundation is properly secured by a variation in design utilizing the local sources of supply with short hauls.

Economy in widths of hard paving is attained by the selection of varying widths that will serve each road or part of a road satisfactorily, and by special shoulder treatment.

Economy in top courses results from a selection of the minimum thickness and the type of surface that will serve satisfactorily the class of traffic to which it is subjected.

Economy of maintenance is attained by preventing damage rather than repairing damage.

The figures given in this article are conservative, and the conclusions have been thoroughly tested and found applicable for this locality.

Automatic Liquid-Chlorine Water Disinfecting Plant

By James A. Newlands*

There has been developed at Stamford, Conn., during the past two years an automatic control for liquid-chlorine disinfection of the water-supply which, so far as the writer is aware, is the first practical installation for automatically regulating the flow of chlorine gas according to the flow of water from a gravity supply.

From the standpoint of bacterial efficiency the treatment of the Stamford water with liquid chlorine has been entirely satisfactory, colon bacilli being almost invariably absent in 10-c.c. volumes of the treated water during the periods when it is found in the raw water. It is from the standpoint of mechanical efficiency, however, that the plant is of greatest interest, and the writer is indebted to Edward L. Hatch, General Manager of the Stamford Water Co., whose interest and personal efforts have made

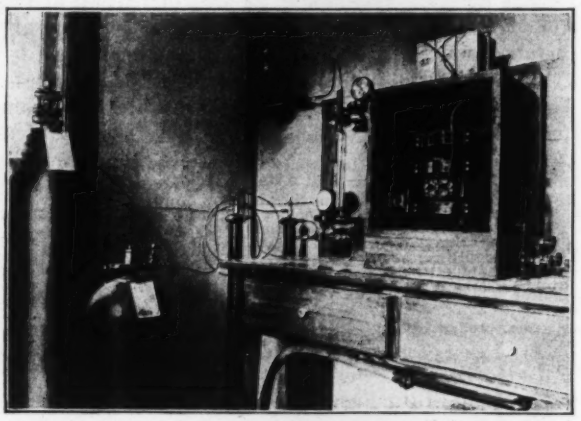


Fig. 1. The Stamford Liquid-Chlorine Feeding Apparatus

(The control of the chlorine flow, as described by the manufacturers, is based on maintaining a drop in pressure through a constriction in the chlorine-gas line proportional to the pressure drop across a venturi constriction in the water main. Holding the drops proportional results in proportional flows of chlorine and water. The diaphragms shown in the figure—one set actuated by a connection with the water venturi throat and another set actuated by a connection with the gas constriction—are so arranged that any difference in their equilibrium, either because of varying flows of water or varying flows of chlorine, will open or close a valve in the chlorine line until the diaphragms return to a position of equilibrium. The chlorine valve is operated by a small electric motor driven by six dry cells, the opening or closing contact being made by the movement of the diaphragms. By the use of comparatively large diaphragms small differences in pressure across the water or gas venturi exert a comparatively large force and result in accurate control of the chlorine discharge over considerable ranges in the water flow. The gas is measured through an orifice, and the flow is indicated on a manometer of the usual type. Two liquid-chlorine tanks resting on standard scales are connected with the apparatus through an automatic three-way valve, which cuts out an empty cylinder, after the reduction in gas pressure, and throws in the full cylinder, thus insuring a constant flow of gas, if the operator is absent when the change in cylinders should be made)

*Secretary, Henry Souther Engineering Co., 11 Laurel St., Hartford, Conn.

possible the accumulation of a considerable amount of valuable data on the mechanical operation of the plant, and on which these notes are based.

The Stamford water-works includes storage reservoirs about 12 mi. north of the city and a 512,000,000-gal. distributing reservoir 5 mi. north that gives something over 100 days' supply.

To guard against accidental contamination of the supply the water company in 1911 installed a calcium-hypochlorite plant. The objectionable features of handling hypochlorite soon led the company to cast about for improvements, and at the writer's suggestion an arrangement was made with Wallace & Tiernan, of New York City,

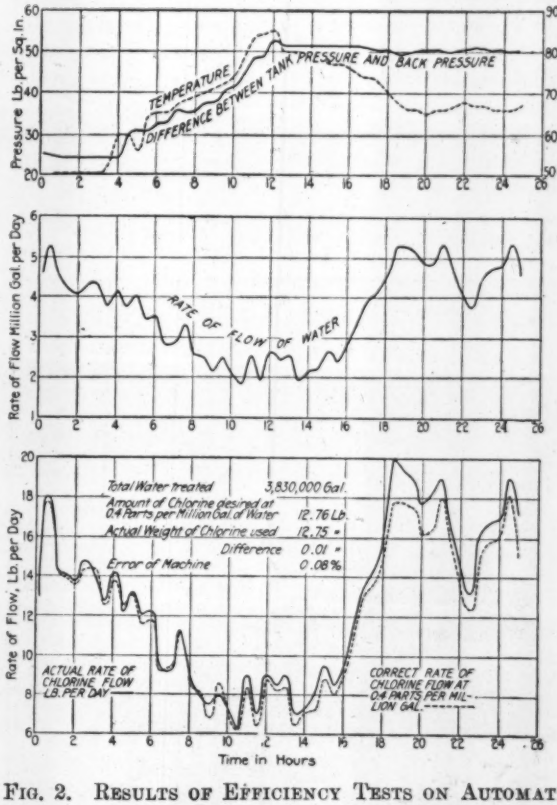

Pressure Lb. per Sq. In.
Temperature Deg. F.
TEMPERATURE
DIFFERENCE BETWEEN TANK PRESSURE AND BACK PRESSURE
Rate of Flow Million Gal. per Day
RATE OF FLOW OF WATER
Rate of Flow, Lb. per Day
Total Water treated 3,830,000 Gal.
Amount of Chlorine desired at 0.4 Parts per Million Gal. of Water 12.76 Lb.
Actual Weight of Chlorine used 12.75 "
Difference 0.01 "
Error of Machine 0.08%
ACTUAL RATE OF CHLORINE FLOW LB. PER DAY
CORRECT RATE OF CHLORINE FLOW AT 0.4 PARTS PER MILLION GAL.
Time in Hours

FIG. 2. RESULTS OF EFFICIENCY TESTS ON AUTOMATIC CHLORINE-CONTROL APPARATUS

(Tests made by the Stamford Water Co. on Mar. 31, 1915)

for trial of a very promising automatic liquid-chlorine dosing device then under development. The plant was put into commission on June 20, 1913, and the description of the installation appended to Fig. 1 may be of interest. The gas, after passing through the controlling device, is piped about 100 yd., from the meter house to the gate chamber, where it is discharged into the water through a carborundum sponge at a depth of about 35 ft.

During the early operation of the plant several difficulties were encountered. A heavy oil-like liquid from the stuffing-boxes of the chlorine cylinders affected the proper flow of gas by clogging the valves. This was temporarily overcome by inserting long cylindrical traps in the gas lines, between the tanks and the control device, as shown in Fig. 1. Later, tanks with dry-packed valves were used. Also small leaks developed around the diaphragms, but this difficulty has been overcome by the use of more resistant material.

The ratio of maximum to minimum daily water consumption and flow is approximately 1:3. In order to determine how closely the chlorine flow varied with the water consumption through sudden changes, a 24-hr. test was made recently, during which readings were taken at half-hour intervals. The results are shown in Fig. 2.

SUMMARY OF RECORDS OF AUTOMATIC CHLORINE PLANT AT STAMFORD, CONN., MARCH, 1914, TO MARCH, 1915

Month	Water Consumption, Gal.	Chlorine, Lb. Used	Chlorine, Lb. Desired	Per Cent. Error
March, 1914	108,400,000	305.35	308.27[2]	—0.97
April, 1914	104,940,000	322.50	326.38	—1.10
May, 1914	106,070,000	396.45	400.50	—1.00
June, 1914	107,190,000	464.00	465.97	—0.40
July, 1914	92,350,000[1]	393.00	421.11	—6.60
August, 1914	107,670,000	537.00	563.67	—4.70
September, 1914	104,710,000	601.50	608.36	—1.10
October, 1914	101,650,000	566.25	590.58	—4.12
November, 1914	89,680,000[2]	412.50	390.57	+5.30
December, 1914	99,520,000	427.50	413.50	+3.2
January, 1915	102,640,000	442.00	410.95	+7.0
February, 1915	95,530,000	402.50	396.45	+1.5

[1]Water consumption July 10-14 not included, as plant was not operated during this period.

[2]Water consumption Nov. 27-29 not included, as plant was out of commission on account of trouble with the liquid-chlorine tanks.

[3]Throughout the year the machine was set for amounts of chlorine varying from 0.5 to 0.7 part per million.

The actual weight of chlorine used in the 24-hr. period varied only 0.08 per cent. from the theoretical amount required. Fig. 2 shows a lag in the chlorine flow at the periods of high water consumption, the maximum excess in this test amounting to about 11%. In the accompanying table are given the monthly totals for water consumption, chlorine used, chlorine desired, and the per cent. error during the past year. The maximum error for any one month is 7%, which is well within the limit necessary for practical requirements. Assuming a lag of 11%, as noted with a required chlorine flow of 0.40 part per million, the amount actually added to the water during this period of error might be as low as 0.35 part per million or as high as 0.44.

Examinations of the water at frequent intervals have shown that with this reduction the bacterial efficiency is not adversely affected. In fact, an error of 25% either way would be permissible, were it not for the possibility of odor trouble, especially during the winter months. Our experience at Stamford has shown that noticeable odors will be produced unless the chlorine flow is kept within a limit of 10 to 15% above the amount required for effective bacterial reduction. At times during the past winter any amount over 0.45 part per million was noticeable. On the other hand, 0.70 part per million was used in warm weather without objectionable results. Accurate regulation of the supply was necessary, therefore, during the cold weather.

The development of automatic feed devices for liquid chlorine is, of course, new, and the success of any installation will depend somewhat on the local difficulties to be overcome. At Stamford the ratio of the venturi throat to the water main is 1:3, giving an appreciable drop in pressure throughout the whole range of water consumption, a condition favoring this type of chlorine control. On other installations, where the ratio of venturi throat to main is smaller, the errors are likely to be greater. Even under this condition, however, errors will not ordinarily go beyond allowable limits.

Numerous improvements in liquid-chlorine feeding devices will undoubtedly be made, but even in the present stage of development they have many advantages over the older hypochlorite plants or manual control of the liquefied gas.

Hardinge Bridge Over the Lower Ganges in India

By F. C. Coleman*

SYNOPSIS—One of the largest steel truss bridges in the world, across the Lower Ganges in Bengal. Over one mile long, of 15 trusses, each of 345-ft. span. Special bank protection above and below abutments. Details of construction, special methods of erection and description of peculiar foundations, claimed to be the deepest in existence.

The Hardinge Bridge† across the Lower Ganges at Sara Ghat, 120 miles above Calcutta, was officially opened on Mar. 4, 1915, by the Viceroy of India, Lord Hardinge, after whom the bridge was named. This largest bridge in the Far East has been under construction for nearly seven years, and its completion marks the beginning of a long-sought-for railway connection from the sea to upper Bengal via the Eastern Bengal Ry. to the south and

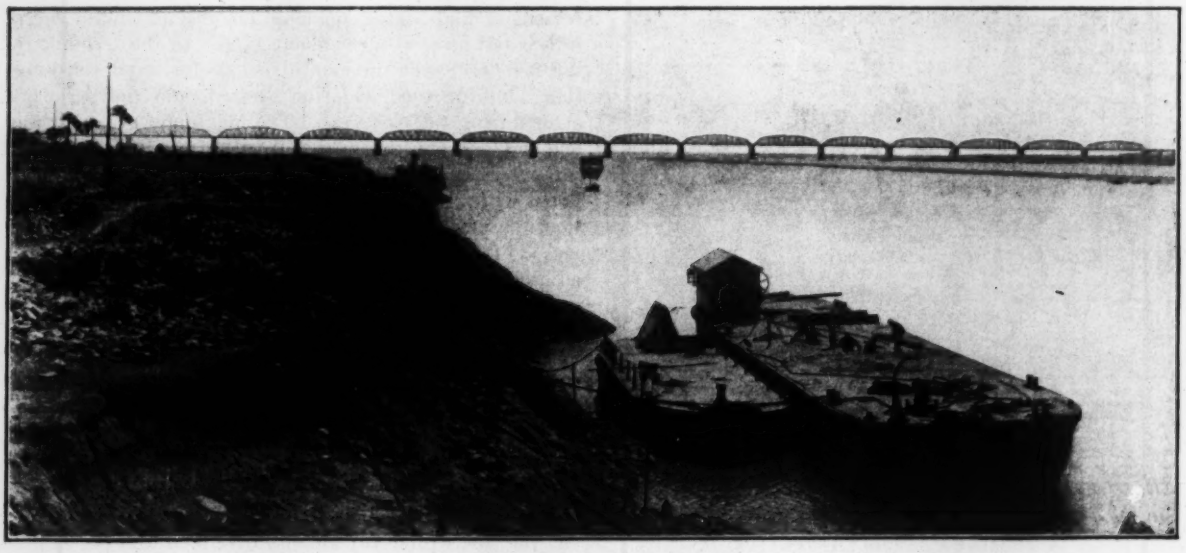


Fig. 1. The Hardinge Bridge over the Lower Ganges at Sara Ghat

numerous branching lines north of the river. The bridge carries a double-track railway on 15 main through-truss spans, each 345 ft. 1½ in. c. to c. of bearings, and three land spans, each 75 ft. long, at each approach. The total length is 5900 ft. In addition to the heavy steelwork and deep foundations, special interest centers in the protection works at each abutment.

Bank-Protection Work

The problem of training and keeping the river to its course through the bridge was the most difficult the engineers had before them. The system adopted was that originated by the late J. R. Bell for rivers with erodible banks. At the bridge site (Fig. 2) there are two guide banks of the Bell bund type, each 4000 ft. long and extending 3000 ft. above the bridge and 1000 ft. downstream. The ends are curved inward and heavily pitched with stone. The bund consists of a core of earth raised 18 ft. above highest flood level, protected on its river slope with a covering of pitched stone 2 to 3½ ft. thick. From the toe of the slope an apron of pitching stone, from 4 ft. 6 in. to 8 ft. 6 in. thickness, is spread outward for a distance of 150 ft. As the river cuts away the earth from under the outer edge of this apron the stone falls down, and eventually the whole apron will lie at a slope in continuation of the pitched slope of the bank to a depth of 100 ft.—the maximum known depth of scour.

It has been possible to make these guide banks shorter than would otherwise have been necessary owing to the existence at Sara, 3 miles above the bridge on the left bank, and at Raita, 7 miles upstream on the right bank, of benches of clay of considerable extent which form semi-permanent points in the banks of the river. To render these points permanent and thus confine the river to a comparatively straight approach to the bridge they have been reinforced with stone-pitched guide banks and aprons each 4000 ft. long.

No stone being obtainable in the vicinity of the bridge, it had to be brought from considerable distances. An idea of the magnitude of the training works may be obtained from the fact that there are about 23,370,000 cu.ft. of pitching stone in the guide banks and 38,600,000 cu.ft. of earthwork. In addition, a reserve of 2,800,000 cu.ft. of stone is stacked near the bridge.

Steelwork

The bridge consists of 15 through-truss spans, each 359 ft. c. to c. of piers, and six plate-girder deck-approach spans, each 95 ft. long, making a total length of bridge of 5890 ft., carrying a two-track broad-gage railway line,

*Central Station Hotel, Newcastle-on-Tyne, England.

†For previous articles see "Engineering News," Nov. 9, 1911, p. 553; Sept. 4, 1913, p. 460; Jan. 15, 1914, p. 118.

a footpath on buckle-plates between tracks and a narrow footway on cantilever brackets outside the downstream truss.

The main trusses have an overall depth at the center of 52 ft.; the width c. to c. is 32 ft., and the total width of the bridge, including the footway, is 48 ft. 6 in. The main posts are spaced 31 ft. 4½ in. c. to c., and a sub-

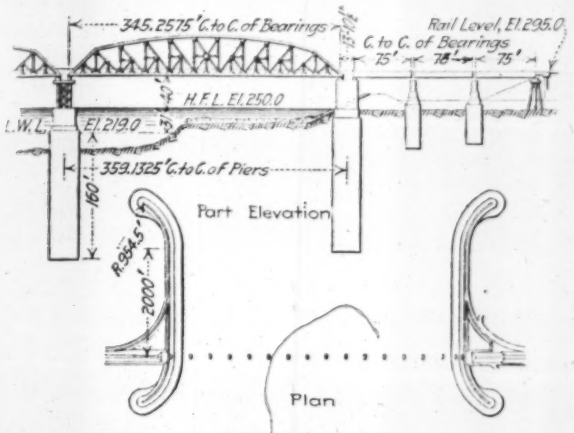


FIG. 2. ELEVATION OF ONE END AND PLAN OF HARDINGE BRIDGE, BENGAL, INDIA

system of bracing reduces the distance between the cross-girders to 15 ft. 8¼ in. Each main post is braced at the center by a latticed strut running to the junction of the subdiagonals and verticals. The chords are built of plates and angles, and each of the largest sections exceeds 43 ft. in length and 16 tons in weight. The main posts and diagonals are built up of angles and plates and are laced with small channels. A feature of the subposts and diagonals is that they are composed of bulb angles diagonally laced with steel tubes having flattened ends. This tube lacing is new in British practice and forms a rigid system, giving maximum strength when used in the form of a strut.

The floor of the bridge is of the open type, the rails being carried on ties laid on longitudinal timbers resting directly on the stringers. Including the footway, but excluding the bearings, the total weight of each of the 15 main spans will be no less than 1216 tons. The bearings, which are alternate fixed and expansion, are of the rocker type. At the fixed ends of the spans the bearings are made in two pieces—a high pedestal bolted to the trestle top and a saddle bolted to the under side of the bearing plate of the span. At the expansion ends the bearings are in three parts—a low pedestal and saddle bolted as before noted and a rocker with knuckle ends fitting into sockets on both pedestal and saddle.

The structural work was carried out in accordance with the British Standard Specification for structural-steel bridges and to detailed designs prepared by Rendel, Palmer & Tritton, consulting engineers to the India Office. The contract for nine of the fifteen main spans was placed with the Cleveland Bridge & Engineering Co., Ltd., of Darlington, England, and for the remaining six spans with Braithwaite & Kirk, Ltd., of West Bromwich, England.

The erection of the trusses formed a very interesting feature of the scheme. Where the river was shallow they were erected on timber staging, carried on piles where necessary (Fig. 3). In deep water the timber staging was replaced by the service truss-span (Fig. 4). This span, which was built by the Patent Shaft & Axletree Co., Ltd., of Wednesbury, England, incorporated with the Metropolitan Carriage Wagon & Finance Co., Ltd., of Birmingham, weighed about 1000 tons and rested on the masonry piers during the erection of a main span on it. It was transferred from span to span on two pontoons, on which were timber stagings of adjustable height. The trusses were erected from an electrically driven traveler straddling the truss and running on a track on the erection truss-span.

The land spans have simple plate-girders, with a trough deck on the top carrying the two tracks and parapets on both sides. They are carried on cast-steel rocker bearings spaced 75 ft. c. to c. The total weight of the steelwork is nearly 21,000 tons, and each span erected and painted is estimated to cost $200,000. There are about 60,000 field rivets in each main span, which were placed with hydraulic and pneumatic riveting machines. About 4000 tons of pine sticks were obtained from America for the falsework. Eight main spans were erected by means of the service span and seven on the three sets of timber centering provided.

PIER CONSTRUCTION

The piers (Fig. 6) are carried on well foundations, the tops of which are 3 ft. above lowest water level. In plan, the masonry portion of the pier is 55 ft. long and 29 ft. wide, with semicircular ends and straight sides. It has a base of reinforced concrete 6 ft. deep. Above that the pier is faced with molded concrete blocks backed with brickwork in cement. There is a cap of reinforced con-

FIG. 3. ERECTION FALSEWORK UNDER SHORE SPAN

crete 6½ ft. deep which incloses a heavy steel grillage foundation to distribute the loads on the trestle legs and temporarily to carry the bearings of the service girder.

The two abutment piers, which carry only one main bearing, have been constructed of masonry to the full height. They have bases of reinforced concrete about 11 ft. deep, and above that they are built of concrete face blocks with a core of mass concrete, and are capped with a 3-ft. slab of reinforced concrete, which incloses steel grill-

ages for distributing the girder loads. In plan the abutment piers are rectangular, 45 ft. 6 in. long and 27 ft. 6 in. wide, with a rectangular recess on the river side. This recess reduces the weight of the pier and helps to centralize the weight on the well foundation.

The masonry of the piers was built by means of the floating stages which were used for sinking the wells. The steelwork of the trestles and grillages was placed in position by ten floating electric derrick cranes and riveted up with pneumatic riveters. In the 16 main piers there are about 47,800 tons of masonry and 3150 tons of steel.

The main piers are carried on wells sunk by open dredging to a depth of 150 or 160 ft. below lowest water level, or 190 ft. below high-flood level, and the cutting edge is 140 ft. below mean sea level. The strata through which the wells are sunk consist of sand with occasional beds of stiff clay. The wells are founded in sand 50 ft. below the deepest known scour line of the river, and the load on the base of the wells allowing for buoyancy, but not for skin friction, is about 9 tons per sq.ft. These are claimed to be the deepest foundations of their kind in the world.

In plan, the wells have semicircular ends and straight sides. There are two dredging holes, each 18½ ft. in diameter. The well curb was built up of steel and filled with mass concrete. It is 15 ft. 7 in. in height and weighs 140 tons. For founding in deep water the curb was continued upward as a caisson by the addition of steel strakes in unit sections of 7 ft. to a maximum height of 65 ft. The caisson is filled with mass concrete. Above the caisson (or well curb when the strakes were not required) the steining of the wells consisted of molded concrete blocks weighing about 6 tons each. The dredging holes were lined with steel to insure watertightness and to strengthen the well. They also act as a form for the mass-concrete filling between them. There are 18 suspension rods of 1¾-in. diameter and 6x¾-in. bond rings every 12 ft. When the well had been sunk to its final depth, the dredging holes were plugged top and bottom with concrete plugs about 18 ft. deep, the remainder being filled with sand.

Some of the well curbs were erected on the exposed shore during the dry season and floated on the rising river in the rains; others were launched on slipways similar to those used for launching ships; but most of them were erected on wooden pontoons and launched by sinking the pontoons under them. Owing to the great amount of work in the well, the heavy loads handled, and the fact that each well had to be sunk to its full depth in one season to render it safe in the following floods, special overhead floating stages, with electric cranes and concrete mixers, were designed for building and sinking the wells.

Generally the floating curb was placed in the staging and the latter moored in position. The caisson strakes were then built up one by one and the well was gradually sunk by filling with concrete until it was near the bed of the river. It was then grounded quickly to avoid scouring and to insure correct position. The bed of the river was previously protected with a layer of sandbags, as a further precaution against scouring under the cutting edge of the curb. In order to obtain a quick grounding the dredging holes of the caissons were provided with water-tight false bottoms, which when opened gave the caisson a sudden increase of draft and brought the cutting edge of the curb to a firm bearing on the sandbags. The false bottoms were then removed and the filling of the caisson with concrete was completed. The well was then sunk by the 100-cu.ft. dredges, the concrete block steining being built up as the well went down.

Material

In each main well there are about 15,300 tons of masonry and an average of 355 tons of steelwork. The stone for the pitching of the training works, for the concrete in the bridge masonry, and for the ballasting of the line was quarried at the three bridge quarries at Phudkipur near Rajmahal, at Pakur on the East Indian Ry. loop line, and at Jainti at the foot of the Himalayas. The stone was transported from Pakur and Jainti, distant 234 and 218 miles respectively, by train, and from Phud-

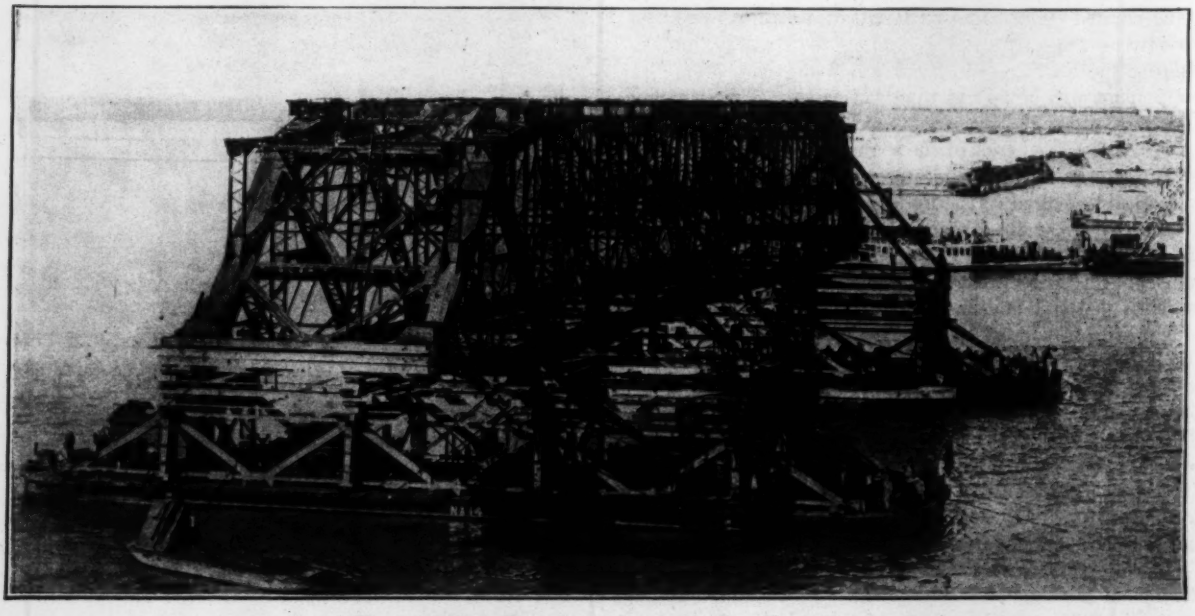


Fig. 4. The Erecting Span on Its Floats

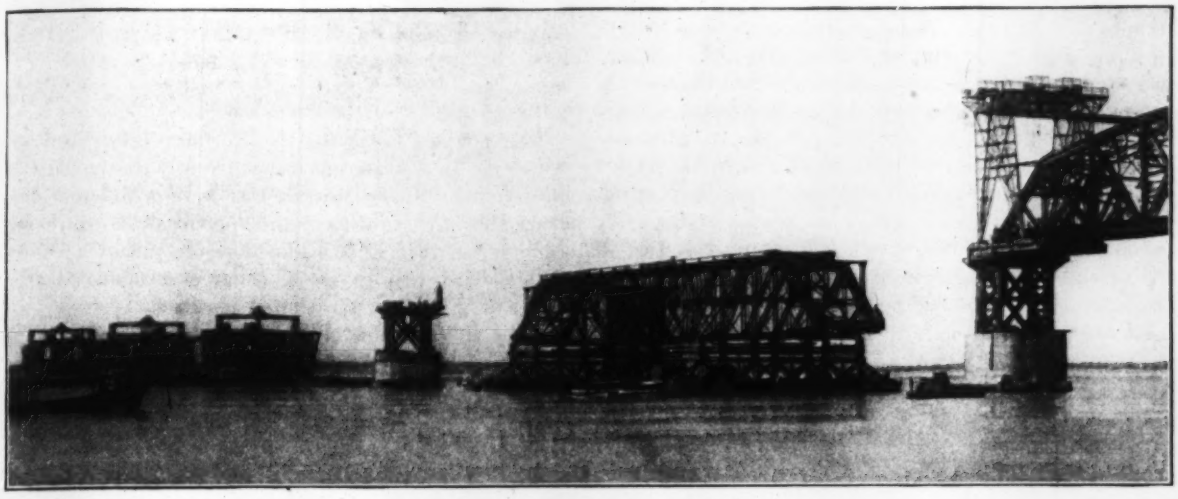


FIG. 5. VIEW OF THE HARDINGE BRIDGE DURING ERECTION
(Note traveler on pier at right and erecting span being floated into place)

kipur, 134 miles distant, by a chartered fleet of steamers and flats. These three quarries supplied not less than 38,860,000 cu.ft. of stone. Building sand was "trained" from Khanyan on the East Indian Ry. and Siliguri on the Eastern Bengal Ry., and 170,000 bbl. of cement was obtained from England through the Stores Department of the India Office. The concrete blocks for the wells and the face blocks for the piers were molded in blockyards on both banks of the river.

PLANT

Each blockyard had its full plant equipment, including a 10-ton, 53-ft.-span goliath crane, concrete mixers, stone crushers, tramways, forms, etc., and that on the left bank had a special molding shed and overhead trolley gantry for making and handling the face blocks. About 24,000 well blocks and 16,000 face blocks were molded in these blockyards. The girders were received in girder yards and unloaded by 20-ton steam traveling jib cranes on to grids, on which they were systematically sorted and stacked. All material consigned to the Sara bank of the river crossed the Ganges by the Eastern Bengal Ry. broad-gage ferry and was run into the storeyards on the Lower Ganges Bridge mixed-gage. Materials for river work were taken out on pontoons, and the barges were handled by the floating cranes.

Power and light were supplied from two power houses, one on each bank, capable of generating 1125 kw. The alternating current was generated at 440 volts, transmitted at 3300 volts and transformed down to 440 for machines and 110 for lights. The plant—necessarily a heavy item in such a work as this—included: 2 erection travelers; 2 10-ton, 53-ft.-span goliath cranes; floating derrick cranes; 5 fixed and traveling 10-ton hand cranes; 10 15-ton overhead cranes on the sinking sets; 2 paddle steamers, 3 steam launches, 3 motorboats and about 50 pontoons and barges; broad-gage, meter-gage, 2-ft. 6-in. gage rolling stock, including 24 locomotives, 28 cars and about 830 trucks; 81 miles of broad-gage, meter-gage, and 2-ft. 6-in. gage service track; pneumatic and hydraulic riveting plant; 21 concrete mixers and 5 stone crushers; power-house plant and equipment, etc.

The section of line which includes the bridge and its approaches is about 15 miles long. It takes off from the Eastern Bengal Ry. just north of Bhairamara Station and joins the northern section of that railway about 3 miles south of Gopalpur. From the Calcutta side the approach line is graded up to the bridge at 1 in 400 for a distance of about 3¼ miles. On the Siliguri side there is 2000 ft. of level at Paksey Station, and thence the line is graded down at 1 in 500 for about 3¾ miles.

At the abutments the approach banks are 50 ft. high. The earthwork in these approaches reaches the enormous total of 160,000,000 cu.ft. There are five roads under

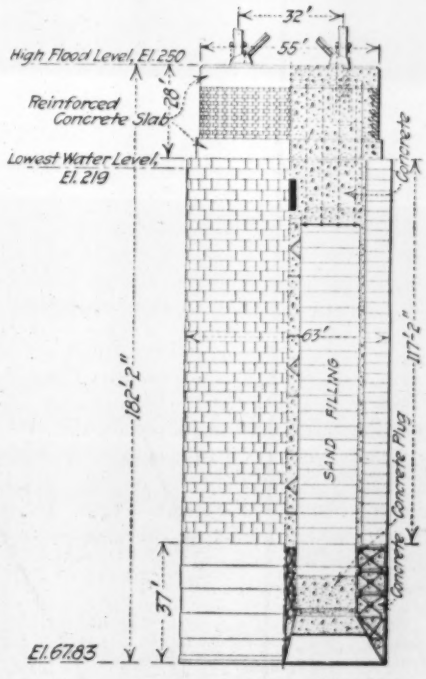


FIG. 6. DETAILS OF DEEP PIERS FOR HARDINGE BRIDGE ACROSS THE LOWER GANGES

bridges through the high approach banks and two small culverts for local drainage. Beyond the northern approach grade there are four culverts for local spill-water and drainage. These culverts are heavily protected against

failure in flood time. The magnitude of the work will be realized when it is said that 38,800,000 cu.ft. of stone has been excavated for use in the bridge and the training works, and this stone has been carried an average distance of nearly 200 miles by train and flat. In the piers and girders there are over 299,000 tons of masonry and nearly 30,000 tons of steelwork. At high-flood level about 2,500,000 cu.ft. of water passes under the bridge every second. About 170,000 barrels of cement was used in the bridge and its approaches, and in each main span there are approximately 60,000 field rivets and 50,000 in each well and pier, or a total of about 1,700,000 rivets in all; while more than 5000 tons of American pine is in the girder centering and jetties. At one time—February, 1912—the labor and staff employed on the bridge works numbered no fewer than 24,400 persons. This large force, made up mostly of natives, necessitated the maintenance of two large villages, one on each side of the river, with sanitary and other municipal conveniences comparable to native villages of similar size.

The estimated cost of the bridge is:

		Lakhs.	
Bridge proper....	Training works....	113	($3,767,000)
	Piers and girders...	194½	(6,483,000)
Plant.....	General charges, service work and preliminary expenses	85	(2,833,000)
		392½	($13,083,000)
Approaches		84	(2,800,000)
Total		476½	($15,883,000)

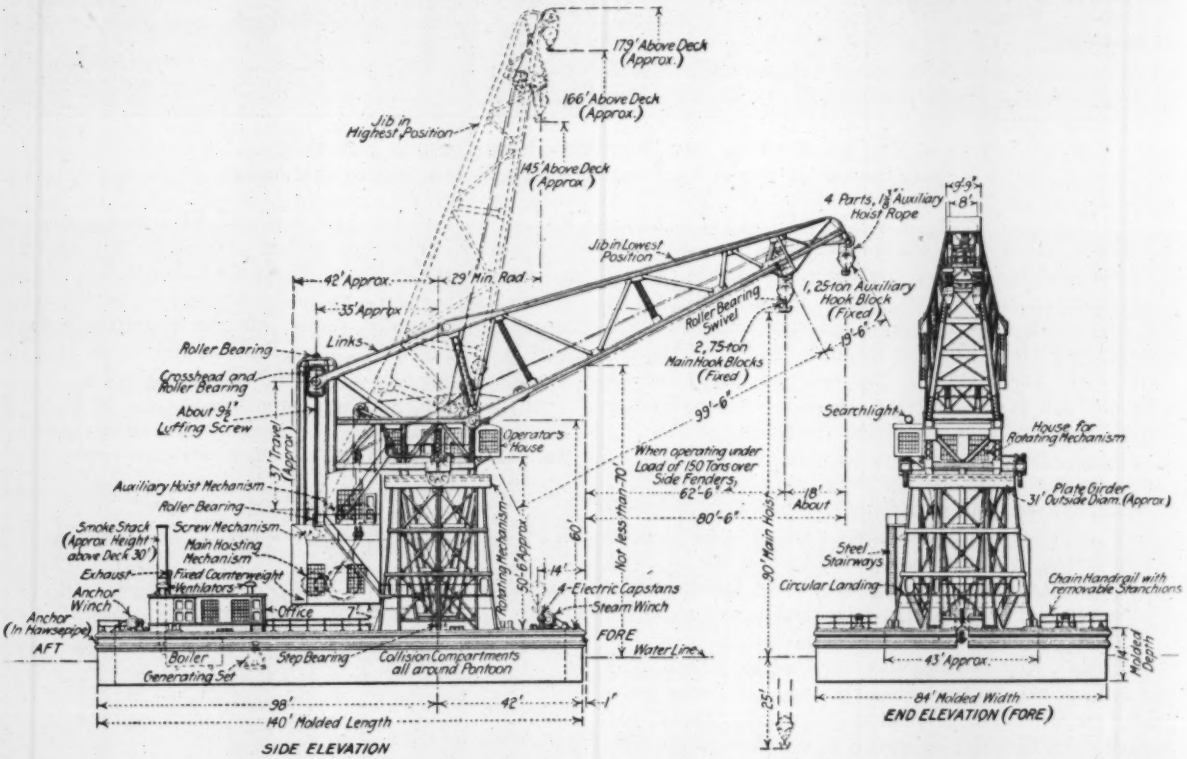
The engineer-in-chief throughout the work was R. R. Gales, and the consulting engineer Sir Alexander Rendel, of London.

New 150-Ton Revolving Floating Crane for Norfolk

By A. F. Case*

The floating crane for the Norfolk Navy Yard, for which the U. S. Government has recently contracted with the Wellman-Seaver-Morgan Co., is of a different type from the large floating cranes previously built in this country, in that it is made to revolve about a central pivot. This will be the first large revolving floating crane to be built in the United States.

The crane will be electrically operated, power being supplied by a steam-operated generator set, which will be placed in one of the compartments of the pontoon.



General Drawings of 150-Ton Revolving Crane for Norfolk Navy Yard

(To be built by the Wellman-Seaver-Morgan Co. Weight, 5,000,000 lb. Contract price, $350,940)

Structure and Operation

The crane will consist essentially of a large steel pontoon, upon which, *equidistant from one end and the two sides*, will be a fixed tower connected rigidly to the pontoon structure. Within this tower will revolve a pivot frame from one side of which the machinery house will be suspended. The opposite side of this pivot frame will carry the hinge pins for the jib, which will be operated by means of links attached to heavy pins in the back end of the jib. These links will be connected to a crosshead moving between vertical guides at the rear of the rotating structure.

The crane will be capable of lifting 150 tons at a maximum reach of 62½ ft. over the side fenders and approximately the same distance over the end fenders.

*Engineer for the Wellman-Seaver-Morgan Co., Cleveland, Ohio.

The maximum lift (150 gross tons) will be accomplished by means of two separate 75-ton hooks; they will be capable of hoisting a load vertically from a point 25 ft. below the surface of the water to 90 ft. above the water. In addition to these two main hooks an auxiliary hook of 25 tons capacity will be suspended from a trolley on the boom in such position that it will be capable of hoisting from a point 25 ft. below the water to 130 ft. above the water at the maximum reach of 62½ ft. beyond the fenders. This trolley will travel on a runway suspended from the under side of the jib and will be capable of traveling the entire length.

The arrangement of mechanism will be such that the jib may be luffed under load from the maximum reach to the highest position, giving a minimum reach of approximately 29 ft. The crane will also be capable of rotating under full load at maximum reach.

All the operating machinery for the different functions of the crane will be placed in the machinery house on the rotating structure. The operator's cab will be placed forward of the machinery house, where all the operations of the crane will be in clear view.

The pontoon will be fitted with four electric capstans and two anchor winches. The latter will be placed forward and aft on the pontoon structure.

General Details

The entire weight of the rotating structure will be carried on a step-bearing securely attached to the pontoon at the center of the fixed tower. The horizontal load on the pivot frame will be taken off close to the deck by means of a circular bearing and at the top of the stationary tower by means of a roller bearing. The rotation will be accomplished by means of two heavy steel pinions meshing with a bevel-gear ring secured to the top of the stationary tower. These pinions will be geared to an electric motor located in the rotating structure.

The machinery for luffing the boom will be at the rear of the rotating structure and will consist of two motors geared to the luffing screws. These screws will be supported on conical roller bearings and will pass through heavy nuts in the luffing crosshead, to which links attached to the jib are connected. The arrangement of the crosshead operating the jib is such that when the latter is in the extreme outer position, the greater part of the load on the jib-supporting links is taken as a horizontal load on the vertical crosshead guides, thus minimizing the vertical load on the luffing screws.

The machinery for operating the main-hoist blocks will be placed at the bottom of the rotating framework and will consist of two separate duplicate units. Each unit will consist of a winding drum geared to its motor, and arrangements will be made so that the separate units can be positively connected for simultaneous operation of the two main hooks when handling the same load. Two ropes will lead from each drum over deflecting sheaves in the structure, and the reeving will be such that each 75-ton block will have eight parts of cable. The main hoist mechanism will be provided with dynamic braking controllers for manipulating the load. The main-hoist blocks (two in number) will each be provided with four cable sheaves, 45-in. pitch diameter, carried in a structural-steel frame suspended from which will be a 75-ton hook. This hook will be mounted on conical roller bearings and will be of anchor type.

The auxiliary-hoist mechanism will be placed above the main-hoist mechanism and will consist of a winding drum connected to the hoist motor by means of spur gearing. The ropes from this drum will be led over deflecting sheaves in the structure and arranged to form a 4-part hoist system for the 25-ton auxiliary block. This block will have two sheaves carried in a structural-steel frame from the lower side of which will be suspended a 25-ton hook. This hook will also be provided with conical roller bearings and will be of anchor type.

The trolley carrying the 25-ton auxiliary-hoist block will be traversed along its runway by an independent set of mechanism in the machinery house. This mechanism will consist of winding drums upon which the ropes for moving the trolley backward and forward along the boom will be wound. The ropes leading to the forward end of the trolley are of necessity larger than those leading to the back end, on account of the incline of the jib and the necessity of moving the trolley along the jib with the 25-ton load hanging on the hook. These two drums will be provided with the necessary gearing to connect them to the travel motor. With this arrangement of mechanism it is possible to traverse the trolley from one end of the jib to the other when the jib is in any position. When the trolley is in the extreme rear position on the jib it will be possible to land material on the deck of the pontoon at a minimum radius of approximately 24 ft.

All of the motors used in connection with the various mechanisms are of one size and will be provided with magnetic-switch control, the master controllers being located in the operator's cab. The supply voltage will be 250. The generating set consists of a noncondensing compound engine direct-connected to a 150-kw. direct-current generator, and is supplied from a 200-hp. marine boiler.

A deckhouse will be built to cover the deck openings of the boiler and generator compartments. One corner of this deckhouse will be finished for an office. A steam-heating plant will be provided for the office.

The pontoon, of steel construction, will have the following molded dimensions: Width, 85 ft.; length, 140 ft.; depth, 15 ft. The water-tight compartments will extend entirely around the outside of the pontoon, and in addition the pontoon will be provided with necessary full-depth bulkheads to secure the required strength and rigidity.

Production of Potash from Feldspar by a new process is described by E. W. Coggeshall in a paper before the National Lime Manufacturers' Association. Powdered feldspar is mixed with one-fifth its weight of powdered quicklime and sprinkled with a solution of calcium chloride. The calcium chloride unites with the lime to form an oxychloride cement which binds the powder into lumps. These lumps are fed to a rotary kiln similar to a cement kiln, and under the influence of the high heat the potash in the feldspar is released from its union with the silica and unites with the chlorine to form muriate of potash, which is readily soluble in water. By leaching the lumps discharged from the kiln, a solution of about 10% of muriate of potash is obtained. The water in the solution is evaporated by the waste heat from the kiln gases. It is stated that the potash salts obtainable in this way can be produced commercially for a lower figure than those imported from Germany under normal conditions. The total importations of potash salts from Germany during 1914, notwithstanding the interruption to the business during the last four months of the year, amounted to nearly 486,000,000 lb., valued at $8,750,000.

Refuse Incinerator, Florence, S. C.

By McKean Maffitt*

Previous to the erection of the Nye incinerator at Florence, S. C., all of the trash and garbage from the city were disposed of by dumping on swamp land and the night soil was used as a fertilizer. The night soil was hauled to the lands by city forces and dumped from

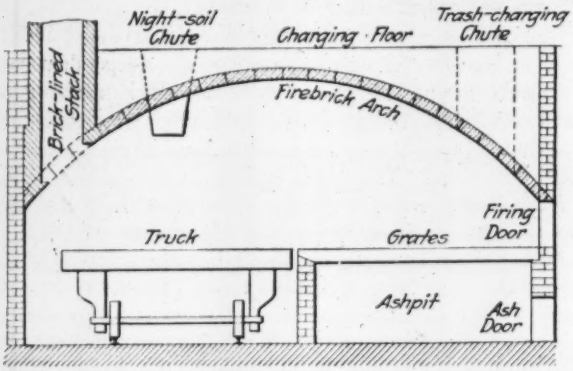


Fig. 1. Sketch-Section of Nye Incinerator

covered carts, after which the owner of the lands would plow it under.

In March, 1914, the Nye Odorless Incinerator Co. installed a 12-ton incinerator, which was guaranteed to dispose of all city-run wastes and night soil with no additional fuel and without odor or other nuisance. The supposition was that the night soil would be fairly well drained of liquid matter.

Previous to the erection of the incinerator the city council requested the citizens to burn on their premises all such wastes as were readily inflammable and would create no nuisance, so that there would be less material to haul to the dump, and the Health Department adopted as a standard the Asheville type of privy, which has a 15x 15-in. galvanized-iron container and is built with a fly-proof compartment. The reduction of the combustible in the trash and garbage left only a small amount of combustible for use at the incinerator. The adoption of the "can closets" largely increased the amount of liquid matter in the night soil. At present the contents of most of the cans as they arrive at the incinerator are from 50% to 75% liquid or semi-liquid matter which cannot be dumped in the incinerator but must be drained very thoroughly, as only the heavier residue can be burned.

*Superintendent of Water and Sewers, Florence, S. C.

The garbage and refuse are hauled to the incinerator, which is at an old dump pile. All loads of an incombustible nature are dumped as before, and only the comparatively combustible material is incinerated. From the charging floor or platform the refuse is forked directly into the incinerator through the trash-charging door shown in Fig. 1. The material is leveled upon the flat herring-bone grate bars. The wood, etc., that comes in the refuse is fed through the three fire-doors.

For the disposal of the larger dead animals the truck shown in Fig. 1 is rolled out through the large door shown in Fig. 2 and horses, mules, cows, etc., are placed upon it. It is then pushed back into the furnace and the animals are completely cremated. The night-soil chute shown in Fig. 1 delivers the strained night soil to the inner end of the truck, where it is consumed.

After a charging period the furnace is allowed to cool over night. The large door is then opened and the operator rakes all the unconsumed material, such as cans, glass and old iron, from the grates onto the truck, which is then rolled out of the furnace on the track and dumped on the spoil bank.

The night soil is brought to the plant on one-horse carts (Fig. 3). Full cans are unloaded at the wash plant (Fig. 4). The truck is immediately reloaded with clean empty cans in which there is a small amount of disinfectant. The full cans are then taken by the washer and dumped into the screen pit of the wash plant (Fig. 4).

Practically all of the liquid and semi-liquid matter drains into the sanitary sewer that leads to the septic tank. The viscous and heavier matter that does not drain into the sewer is washed down by a small stream of water under about 50 lb. pressure. The mass at the same time is raked over, and all rags, sticks, heavy paper and other insoluble matter is taken out and shoveled into a small opening at the top of the incinerator (Fig. 1).

The average amount of garbage and refuse that has been disposed of for the one year's operation is 25 one-horse loads a day, of which about six loads are placed on the old dump. The average amount of night soil per day is 180 cans (15x15-in.), which are usually about two-thirds full. Practically 90 per cent. is washed into the sewer, leaving only a small amount to be burned.

The entire plant, including a stable for eleven head of stock, is looked after by one operator and two helpers (one washer and one fireman).

Under present conditions the plant has barely enough combustible at times to maintain a good fire, but when there is a run of good trash the heat generated is suf-

Figs. 2 to 4. Garbage-, Refuse-, Dead-Animal-, and Night-Soil-Disposal Plant at Florence, S. C.
(2, Exterior view of incinerator. 3, Night-soil cans and cart. 4, Stand for draining liquid portion of night soil to sewer and washing the cans)

ficient to consume not only the refuse but also the carcass of a horse in less than a half-day, and when there is a fair run of trash there is no trouble in normal operation of plant.

The washing outfit was erected complete by the writer and was designed especially for the purpose of washing the cans. So far it has given entire satisfaction, there being no great amount of odor from the wash pit except when dumping the cans. The amount of wash water used averages 16,000 gal. a month.

Flexible Bronze Tubing of the Partridge Island Pipe Line

One of the most novel water-supply pipe lines in existence is the 4-in. flexible bronze-tube main laid under the harbor of St. John, N. B., from the mainland to Partridge Island.

Partridge Island, at the entrance of the harbor, has an area of about 30 acres and is used as an immigration quarantine station and as a training depot. The island is 3500 ft. from the nearest point of the mainland at high tide and 1490 ft. from the end of Negropoint Breakwater, which partly closes the west channel. Owing to the great tidal range (28 ft.) a flow of from 2 to 3 mi. per hour is sometimes encountered in this channel. Moreover,

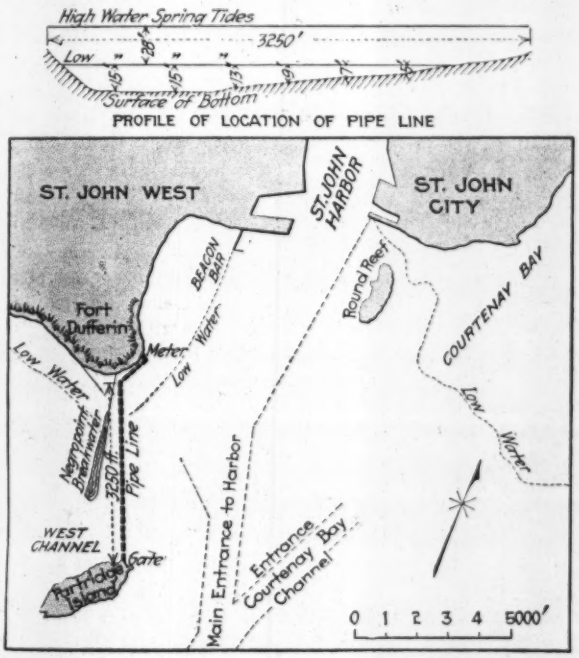


FIG. 1. LOCATION PLAN AND PROFILE, PARTRIDGE ISLAND PIPE LINE

the tide here sets outward strongly until nearly half flood, owing to the reversing falls at the outlet of the St. John River.

TROUBLES OF THE OLD LINE

In 1906, a 6-in. extra-heavy galvanized wrought-iron pipe with ball-and-socket joints was laid across the west channel from the mainland, connecting with the city mains, to provide Partridge Island with a fresh-water supply. This pipe, in 18-ft. lengths, was connected up on a scow and lowered into a dredged trench for 2000 ft. where it was protected by the breakwater. But it was placed on the surface across the channel, where the bottom is very level. The joints allowed the pipe to bend in the laying 20° at each connection. While this pipe is claimed to have been tight when completed, it was damaged almost immediately by the anchor of a vessel and was probably strained in several joints. On one occasion, within a year of its completion, the fresh water in the submerged

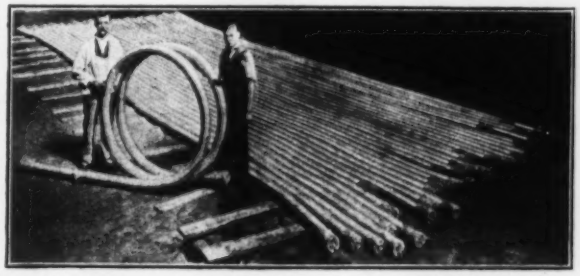


FIG. 2. PART OF THE FLEXIBLE BRONZE TUBING FOR PARTRIDGE ISLAND

pipe froze and the salt water was found to have a temperature of 31 deg. F. The pipe never gave satisfaction, and in five years more money had been expended on searching for and repairing leaks under the water than the original cost of the pipe; while only an intermittent supply had been provided and an immense amount of fresh water wasted. In 1912 the wrought-iron pipe was finally condemned entirely.

THE FLEXIBLE-TUBE LINE

To replace this pipe, a 4-in. flexible bronze tubing was chosen, being considered especially adaptable for this work owing to its flexibility, weight, and durability in salt water. While the tubing itself was considerably more expensive than wrought-iron pipe, per lineal foot, the joints were much cheaper and fewer in number, and the ease with which the tubing was handled made the line less expensive than the original one. In order to protect the fresh water from possible contamination by contact with the bronze, the strip from which the tubing was made was heavily tinned on the inside.

The tubing, as specified, consists "essentially of a single strip of bronze wound helically, each winding overlapping and interlocking with the last, the joint thus formed being packed with asbestos." The bronze was required to contain 98% copper. The coupling was threaded to the grove on the outside of the pipe and soldered tight. The tubing was supplied in 30- to 40-ft. lengths, with couplings attached.

Instead of allowing the new pipe to lie exposed on the bottom it was buried in a dredged trench 6 ft. deep, the whole way across the channel. Since the material in the channel was generally sand and gravel, the pipe had to be laid immediately behind the dredge, as the trench would fill rapidly. On one occasion the end of the pipe was buried in the trench in a storm, and a hole 12 ft. deep had to be dredged beside the end of the pipe, until the material fell away and uncovered the end.

In laying, the tubing was placed from a steam scow on which a wooden reel 12 ft. in diameter had been erected. Some 200 ft. of the tubing was connected up at a time, wound on this reel and subjected to a pressure of 200 lb. per sq.in. from an engine pump, one end of the tubing

being capped. It was then connected up with the section already laid and this connection tested. The scow was then pulled ahead along the dredged trench, which was marked by ranges on shore, and the pipe, unwinding from the reel, was allowed to slide down an inclined and partly submerged platform. Detachable, tagged lines, with buoys, were attached to the tubing every 50 ft., and by the aid of these lines and sounding along the pipe it was

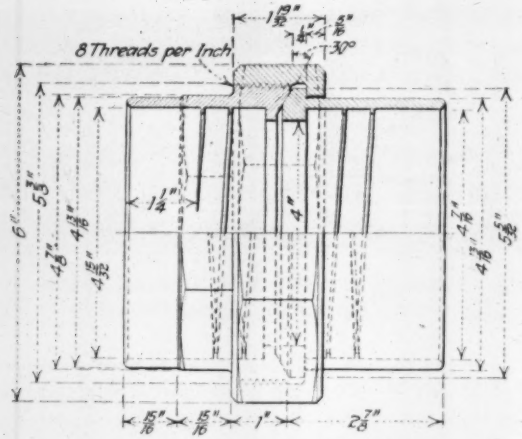


FIG. 3. SPECIAL COUPLING FOR FLEXIBLE TUBE PIPE LINE

possible to see that the tubing was placed satisfactorily in the trench.

The work was much delayed by bad weather, and the actual placing of the tubing was delayed by the dredging, since part of the time it was necessary to employ a large dredge, which could only work during high tide. The actual work of testing and laying the tubing, exclusive of delays from weather and dredging difficulties, took only 25 days, while the maximum length laid in one day was 600 ft. The scow had to be towed about a mile and a half from the wharf, where the pipe was loaded and

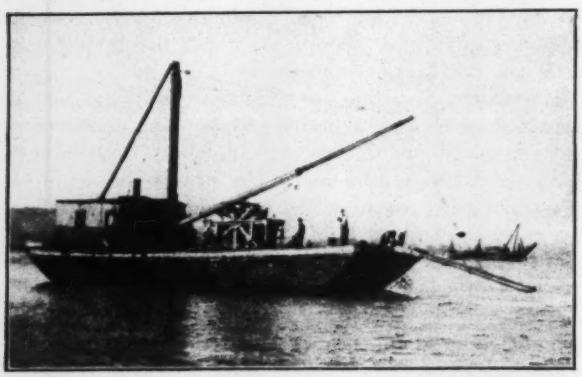


FIG. 4. STEAM SCOW WITH REEL FOR LAYING PARTRIDGE ISLAND PIPE LINE

tested, to the site of laying. The party consisted of a foreman and ten men, and the average cost per day, including the hire of a scow and gasoline towboat, was about $70.

For the greater part of the distance the trench filled quickly and buried the pipe, but near the inner end of the breakwater a few scowloads of soft mud were dumped in the trench to cover.

The tubing has given entire satisfaction. It is absolutely water-tight, as shown by frequent tests, when the gate on the island end of the pipe is closed and meter readings are taken at the mainland. An analysis of water that remained in the line 24 hr. showed only a little iron. During six months 3,800,000 gal. of water has been supplied to an average number of 325 people on the island; and a pressure of 40 lb. per sq.in. has been maintained at the highest point.

No previous case of such use of metal hose was known and it was first recommended for this situation by the United Metallic Tubing Co. of England. This company put in the lowest tenders for the material, but could not fulfill the conditions of delivery. Purchase was made after the tender of the Canadian Fairbanks-Morse Co., representing the manufacturers, the American Metal Hose Co., of Waterbury, Conn.

Licensing Land Surveyors in the Canadian Provinces

BY J. A. MACDONALD*

Among the many regulations we have in Canada, perhaps the most ridiculous is the lack of reciprocity among our land surveyors. An Ontario land surveyor is not permitted to survey lands across the line in Quebec, and vice versa. Further, a Dominion land surveyor, although probably the highest-class surveyor in Canada, is not permitted to survey lands in any of the provinces. These Dominion land surveyors subdivided all the lands in Manitoba, Saskatchewan and Alberta when these lands belonged to the Dominion Government, but as soon as these lands came under the jurisdiction of the several provinces, the Dominion land surveyors were not allowed to do any more survey work.

A similar situation existed for years among Canadian physicians. An Ontario doctor could not practice in Quebec or in any other of the provinces without taking a most severe examination before the Provincial Medical Board. Happily, the folly of this became evident and the laws were repealed, so that now any doctor qualified by a reputable medical college can practice in any province by simply registering.

When will our land surveyors become equally wise? The traversing of a lake or river, the subdividing of a piece of land and the calculation of its area are the same processes in one province as in another; and yet, if a surveyor of one province desires to practice in another, he must take a full examination, as if he were a student. Here at Ottawa the line between Quebec and Ontario is the Ottawa River. An Ontario surveyor cannot go across the river to do any work in Quebec, neither can a surveyor in Hull come across to do any work in Ontario. Neither can a Dominion land surveyor, who passes a more difficult examination than either, do any work in either province.

No doubt, a time will come when the foolishness of the present state of affairs will be evident. The doctors maintained a like situation for years, but their eyes opened and their wisdom teeth grew. We trust the time is not distant when there will be reciprocity among our provincial surveyors.

*Topographic Surveys Branch, Ottawa, Ont.

Chicago's Sewage and Water-Supply Problem

That the means now employed by Chicago in getting rid of its sewage and protecting its drinking water are not satisfactory, and cannot be made so without radical changes of policy and procedure, is the opinion reached after a year's study of this problem by a board of experts, and expressed in an exhaustive report to the Chicago Real Estate Board.* The experts are Dr. George A. Soper, formerly President and Director of the scientific work of the Metropolitan Sewerage Commission of New York; Mr. John D. Watson, Chief Engineer of the extensive sewage disposal works of Birmingham, England; and Major Arthur J. Martin, Consulting Engineer, of London, and the author of a standard book on sewage.

It is declared by the experts to be wrong in principle and in practice to use the unpurified lake water for drinking purposes, to discharge the crude sewage and foul industrial wastes into the open waterways which flow through the city, and to flush this filthy material into the Illinois Valley.

In spite of the $64,000,000 which has been spent for the disposal of the sewage, the Chicago River is now in such a state as to give rise to serious nuisance in places, and the discharge of the filth through the Drainage Canal has made impossible a wholesome state of the Desplaines and Illinois Rivers for one hundred miles from Chicago.

The experts found very few persons in Chicago who seemed to be aware of the conditions in the naturally beautiful and populous Illinois Valley, as shown by the inspections which they made and by the records of various other scientific investigators. By sending the filth which formerly stagnated in the Chicago River down into the valley, the nuisance-producing material has been transferred from one place to another, but it has not been disposed of in the sanitary sense. For many miles the river water is not fit to drink, nor to wash in, nor to water stock in, nor for many of the other domestic, agricultural and industrial uses of a normal river.

Every conceivable kind of filthy thing can be flushed away by water from the streets, houses and persons of the sick and well in a population of 2,500,000 persons, not to mention the excrement of 100,000 head of horses, cattle, hogs and mules cast into the valley in the confident hope that the beneficent forces of nature will somehow dispose of it. And nature does dispose of it, but not without producing conditions which are probably unequaled. The foul condition of the water reaches its culmination at some point between Morris, 62 mi. from Chicago, and the Marseilles Dam, 80 mi. below, depending on the season and, consequently, the rate at which putrefactive decomposition occurs.

A study of the history of the present scheme of disposing of the sewage, and a careful examination of the law which provided for the construction of the Drainage and Ship Canal, have convinced the experts that the intention of the state legislature in passing the Sanitary District Act was to prevent many of the evils which now exist, and which must become greatly magnified with the increase of population, unless radical changes are made. Section 20 of the law of May 29, 1889, states in part as follows:

*See "Engineering News," May 14, 1914, p. 1097.

> Any channel or outlet constructed under the provisions of this act, which shall cause the discharge of sewage into or through any river or stream of water beyond or without the limits of the district constructing the same . . . shall be kept and maintained of such size and in such condition that the water thereof shall be neither offensive nor injurious to the health of any of the people of this state; and before any sewage shall be discharged into such channel or outlet, all garbage, dead animals and parts thereof and other solids shall be taken therefrom. . . .

The Drainage and Ship Canal, if properly used, is capable of aiding in solving the double problem of sewage disposal and water supply, and will provide an important link in the water highway from Lake Michigan to the Mississippi; but it cannot, unaided, perform all the functions which have been expected of it. The canal cannot properly serve both as a river and a sewer. At the present time it is used as a sewer—in the future it should be regarded as a river. All the waterways of Chicago, which at the present time are little else than open sewers, should be redeemed and restored to their natural and appropriate uses.

Intercepting sewers are recommended to take the sewage from the present collecting sewers and convey it to suitable points for disposal, and treatment works in order to fit the sewage for discharge into the Chicago River or the Drainage and Ship Canal, according to the opportunities which can be afforded for carrying the liquid residue away.

Solids which are capable of floating or depositing should be removed from the sewage and as much more improvement effected as can reasonably be accomplished. The removal of the larger solids is a minimum requirement, and will serve as a beginning for a part of the sewage. For the rest, some form of oxidizing treatment, such as the experience of other cities has shown to be practicable, should be adopted. Only that portion of the sewage which the water can carry away and absorb without offense should be emptied into the waterways.

In order to accomplish the results desired, there should be one main disposal plant, located to the west of the city, and various smaller installations elsewhere. The smaller installations would consist chiefly of screening and settling devices; the main plant would provide for more thorough treatment. The works should be capable of extension and development, as the conditions of the future require.

General plans for the collection of the sewage can and should be prepared long in advance of the actual needs of construction, and if this is done in accordance with the best technical practice of the day, there will be provided a definite program of construction toward which all future sewer building can be made tributary. The cost, being anticipated, can be provided for and so distributed as not to prove too serious a burden.

The water-supply should be protected against such pollution as the immense population of Chicago and vicinity and the extensive commerce upon Lake Michigan render unavoidable. The water is now at times turbid, polluted and unsafe for drinking purposes. The experts recommend that it be filtered.

With regard to the carrying out of their recommendations, the experts say in their report:

> We recommend that steps be at once taken to prepare a general plan and policy of sewage disposal which will give to the water-supply all the protection which it is practicable to give and get rid of the sewage without unnecessary danger or offense.

Engineering Literature

A Useful Library Catalog

The Carnegie Library, of Pittsburgh, has recently issued Vol. VI, VII and VIII of its classified catalog. Vol. VI covers acquisitions between 1907 and 1911 of books on fine arts, literature, fiction in foreign languages, history and travel; Vol. VII covers books of the same years on philosophy, religion, sociology, philology, natural science and useful arts; and Vol. VIII indexes works on biography and books for the blind.

Vol. VII, in which appear references on useful arts, is of the most interest to engineers and should certainly be in all engineering libraries for general reference. Bibliographies and indexes of engineering books are rare and especially those of the character published by the Carnegie Library, for these give not only the full title, but a short descriptive paragraph of the contents of every book, of which perhaps the following is typical:

MORRISON, CHARLES EDWARD. Highway engineering. 1908. Wiley.

Brief presentation of fundamentals. Not intended to supplant the more comprehensive treatises such as Baker or Byrne.

To one who has made library researches it is obvious that such a bibliography is of great value. Many entries are longer and more complete than the one given, but in every instance the description is concise and pointed. Many are paragraphs or abstracts from book reviews in this department of ENGINEERING NEWS, and in such instances the author of the review and the source are always credited.

We cannot too strongly commend a work of this kind, the need of which is often felt, and it is to be hoped that the time will come when the work will be extended backward to include books which, while they are of no practical value to the engineer, are important sources of engineering history; for the time is surely coming when engineers will take more interest in this side of their profession.

The Carnegie Library catalogs are bound in cloth, 6x9 in., and may be purchased either in sets or separately. Those interested should address the Carnegie Library, Pittsburgh, Penn.

Library Service for Engineers

The Library Board of the United Engineering Society has established a Library Service Bureau to keep subscribers posted on engineering subjects in which they are particularly interested. The work is of the same character as the research work done by the librarians of the American Society of Civil Engineers and such as the other engineering societies have done to a greater or less extent. This work was for individuals and was charged for according to the time spent in research. The new Library Service Bureau is to give a weekly or biweekly service in the form of card bibliographies of articles on the subject which the subscriber selects. Subscriptions are $10 per annum, and the cards are charged for at the rate of 10c. each. The subscriber also gets special rates on translations, abstracts, searches, bibliographies, etc.

The combined libraries of the American Institute of Electical Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the United Engineering Society, which are now conjointly administered by a library board of the last-named society, receive currently 800 engineering or scientific periodicals and have over 60,000 books on technical subjects. The Library Service Bureau has a staff of experts covering all branches of the engineering profession. It is enabled to furnish accurate abstracts and reliable translations of articles appearing in any language; to compile bibliographies on any engineering subject; to supply copies of articles, and to make photostatic prints of diagrams, maps, plates or printed pages.

REVIEWS AND NOTES

Irrigation Engineering Data

REVIEWED BY H. B. MUCKLESTON*

WORKING DATA FOR IRRIGATION ENGINEERS—By E. A. Moritz, Assoc. M. Am. Soc. C. E., Engineer U. S. Reclamation Service. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xiii + 395; 46 illustrations; 65 tables. $4, net.

The author of this treatise states in his preface that his object has been "to produce a book which would result in the conservation of the time and mental energy of the user, as well as to present material not readily obtainable from other sources"; also that he hopes the book in its present form will prove to be of value to irrigation and hydraulic engineers and that he invites criticisms and suggestions for improvement.

The first three chapters are introduced principally to show the applicability of the tables and diagrams which follow, although they contain a good deal of valuable matter in themselves. They discuss briefly the various features of irrigation engineering in the order of the usual steps in the development of a project.

The first chapter, Examination and Reconnaissance, treats principally of the information on land area and available water-supply which should be acquired before proceeding with any detailed work of design. The book points out how these data may be acquired from various Government or other publications and also gives some useful pointers on the methods to be adopted when the necessary information must be acquired by actual survey or measurement.

Chapter 2 deals with investigation and surveys and treats of the duty of water, location of headworks, determination of irrigable area, reservoir surveys, and canal location. Two very useful tables are given showing the

*Division Engineer, Canadian Pacific Ry. Co., Calgary, Alta.

actual amounts of water used on various projects. The author makes the very pertinent statement that the seasonal distribution of the demand for water is quite as important a factor in the design of the system as the total requirement. The author takes pains to emphasize the great advisability of the locating engineer having had experience in operation.

The third chapter deals with the design of Irrigation Structures, including canals and reservoirs, from the hydraulic point of view. No attempt is made to discuss the mechanical details of design. Under storage is considered the losses from seepage and evaporation. Information compiled from several sources is given from which the probable losses from the latter cause may be estimated. The necessity of ample spillway capacity is touched on and a table of maximum recorded flood discharges for streams all over the country is given which will be useful as a guide when no other data can be obtained.

Diversion Works are treated under Diverting Dams and Headgates, and, as before, the author does little more than outline the procedure to be followed in design and point out the more common pitfalls which should be avoided. Under canals, after outlining the process of design, mention is made of seepage losses and a formula and diagram given from which they may be estimated. The question of cross-section is then taken up and consideration is given to the choice of side slopes and to the ratio of bed width to depth and the conditions which govern it. The matter of limiting velocities and grades, from the points of view of silting and scouring, is next treated. Reference is made to Kennedy's formula and an attempt made to adapt it to American practice. It was never contended by Mr. Kennedy that the formula as he gave it, in a paper first published as Punjab Irrigation Paper No. 7 (May 14, 1896), was adapted to all kinds of silt and all sorts of rivers.

The values given to the constants in the paper are those ascertained by Mr. Kennedy as applicable to the Bari Doab canals in the Punjab. It is found in Burmah and Egypt that the constants need modifying and therefore it is not probable that all American rivers would require the same constants. On the question of scour, a careful reading of the original paper and discussion will show that the formula was not intended to apply to scour in the sense of cutting of bed and banks as it is understood in America, but rather to the picking up of silt previously deposited. Mr. Kennedy states that for very deep channels, the formula gives a non-silting velocity, which would certainly be higher than the material of the bed and banks would stand. In other words, the velocity given is that at which the silt is kept suspended but it has nothing to do with cutting, which follows a very different law. Attention is drawn to this point as it is sometimes contended that the Kennedy formula gives a velocity which will not erode, which is not the case.

The only formula given for flow in canals is Kutter's well-known formula. A long table of experimental values of n is given for reference.

The remainder of the chapter treats of the hydraulic elements in the design of flumes, chutes, pipe lines, drops and other works.

For discharge of pipes, the author gives four formulas, which are merely Doctor Lampé's well-known formula in a new dress. Treating of the design of culverts, the author outlines the necessary calculations, but he omits the old railroad engineer's formula for this purpose. For the benefit of those ignorant of it, it is given here: "Ask the advice of the oldest high-water liar in the neighborhood and then make the culvert three times as big."

Chapters 4 to 6 consist of the tables and diagrams, which the author states in his preface form the real purpose of the book. Chapter 4 consists entirely of hydraulic tables and diagrams. Out of 35 diagrams in this chapter, 17 are for the solution of Kutter's formula. It is difficult to understand the continued use of this formula. Probably one explanation lies in the truly enormous collection of tables and diagrams which has grown up around it. Certainly, if one is obliged to use the formula constantly, some such aids are necessary, and one could understand this steadfast adherence if it could be said that the formula, although complicated and cumbersome, was correct. But when it is known that it does not correctly represent the law of flowing water, it is difficult to see why much simpler and more easily handled formulas are not used. For instance, Manning's formula, which can be solved with a slide rule and which agrees with the observed facts quite as well as does Kutter's, is

$$V = \frac{1.486}{n} r^{\frac{2}{3}} s^{\frac{1}{2}}$$

where n has the same value as in Kutter's formula.

The remainder of the chapter contains a number of tables and diagrams for the solution of various hydraulic formulas, and at the end of the chapter all the various formulas are brought together into a convenient table.

Chapter 5 consists of tables and diagrams for structural calculations—earthwork, design of retaining walls, reinforced concrete, timber, pipes, etc., concluding with diagrams for calculating hydrostatic pressure and horsepower of falling water.

Chapter 6 is a scrap heap of information on a variety of subjects, most of which can be found in the various engineering pocket books.

The final chapter is a collection of specifications on a wide variety of engineering work, most of which are apparently from the United States Reclamation Service. The clauses given are useful as models, but great care should always be exercised in copying them. It must be remembered that Governments and other sovereign powers have unique privileges at law.

Since the volume is too large for a pocket book, it appears that it would be still more useful had the pages been somewhat larger. Most of the diagrams are reduced to such a small scale that they are somewhat difficult to read. The omission of any reference to Bazin's new (1897) formula is a defect, which it is hoped later editions will correct. It might also be well to emphasize again the value of the very simple Manning formula and to suggest that it also be inserted when the opportunity arrives. Another noticeable omission is any formula for the design of notched drops.

To practicing engineers who have to do much calculations in hydraulics the book should prove very useful, especially to those who are not expert in the use of the slide rule and to those who insist on the use of Kutter's formula.

The various applications of the several shapes of steel sheetpiling manufactured by the Lackawanna Steel Co. (Lackawanna, N. Y.) are described by views and text in

a bulletin just issued by that company. Among other interesting items is a statement of the inverted-hammer method of extracting sheetpiles, which was described in ENGINEERING NEWS, Feb. 4, p. 218. Nine pages are devoted to a discussion of driving apparatus and requirements.

Chiefly on Simple Bridges

REVIEWED BY LEWIS E. MOORE*

STRUCTURAL ENGINEERING—By J. E. Kirkham, Professor of Structural Engineering, Iowa State College; Consulting Bridge Engineer, Iowa Highway Commission; formerly Designing Engineer with American Bridge Co. Chicago: The Myron C. Clark Publishing Co. London: E. & F. N. Spon, Ltd. Cloth; 6x9 in.; pp. iv + 669; 452 text illustrations. $5, net.

This volume is devoted chiefly to simple bridges. The author states in the preface that it is intended as a "text-book for college students and as a self-explanatory manual of structural engineering for practical men," and that he "has endeavored to present the usual methods, and this in such a fashion that the average engineering student as well as the practical man can read understandingly without having a dictionary, glossary or a compendium on theoretical mechanics at his elbow."

The first chapter takes up very briefly the manufacture of steel, the driving of rivets more at length, the order in which work is done in structural shops and the fabrication of structures. Chapter II is devoted to rules for structural drafting. The next chapter (27 pages) treats of forces, reactions, elasticity, graphic statics, center of gravity, and moment of inertia. Chapter IV (55 pages) is devoted to moments, shears, reactions, and deflections in simple and continuous beams. Nine pages are given to the theoretical treatment of columns. The derivation of Rankine's and the straight-line formulas are given, with examples. Formulas are derived for stresses in columns under eccentric loading. Chapter VI (9 pages) treats of rivets, pins, rollers, and shafting. The methods of finding maximum reactions, shears, and moments are followed by a chapter on graphic analysis of trusses and a short chapter on influence lines. Chapter X gives a number of examples of I-beam and plate-girder designs.

In the succeeding 338 pages various designs are worked out: Chapter XI deals with two I-beams, including shop drawings and shop bills; two deck plate-girder spans, including drawings and shop bill for one of them; one through plate girder, some solid floors, a viaduct, a 150-ft. through riveted Pratt truss railroad bridge, including drawings and estimate of weight; a 225-ft. single-track through curved chord pin-connected Pratt truss, including stress-sheet and drawings. The chapter closes with several pages on the analytical determination of deflection and camber. In Chapter XII the following simple highway bridges are designed: Two beam bridges, a pony truss, and a through truss. The next chapter treats of skew bridges and bridges on curves and gives the economic depth of trusses in the form of a table. The last 83 pages take up mill buildings and give a few tables of various structural properties.

The author's style is clear and straightforward, but the treatment is almost wholly from a practical standpoint, at the expense of the philosophy of the subject. Too many similar examples are worked out and too much stress is laid upon shop drawings and shop bills. A very small proportion of engineering-college graduates go into structural work, and only those who do can make use of knowledge of shop bills, etc., and even these can spend their time in college more advantageously. It is far better to emphasize the philosophical side at the expense of the practical. The treatment of columns is meager and unsatisfactory. It seems that the book will be more useful to the young draftsman without a college training than to the college student.

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The Railway Regime on the Panama Canal

WHO BUILT THE PANAMA CANAL?—By W. Leon Pepperman, Chief of Office of Administration of the Second Isthmian Commission. New York: E. P. Dutton & Co. Cloth; 6x9 in.; pp. xiv + 417; illustrated. $2, net.

The author of this book has undertaken the difficult task of awarding credit where credit is due for the construction of the Panama Canal. He writes from first-hand knowledge, as he was in charge of the Washington office of the Canal Commission from the time the first commission was appointed, in the early part of 1904, until the work was turned over to the army engineers in 1907. The author begins his story practically with the appointment of the Isthmian Canal Commission of 1904, at which time the building of the canal, as distinct from its planning and survey, may be said to have been begun. There is thus no mention of the earlier history of the canal, such as the examination made of the Panama route by the Ludlow-Endicott-Noble Commission in 1895, or the elaborate studies made by the Isthmian Canal Commission of 1901. The author does, however, devote a good part of a chapter to the work of the French in the Canal Zone, and gives large credit to the French engineers for the amount of work they accomplished under vast difficulties.

The book is chiefly devoted to the work done during what the author terms "the railroad régime" at Panama, by which he designates the period from the appointment of Theodore P. Shonts as chairman of the Canal Commission in 1905 to the resignation of John F. Stevens as chief engineer in 1907. The author accords to Mr. Shonts a large measure of the credit for bringing order out of chaos on the Isthmus and relates some hitherto unpublished incidents of the way in which Mr. Shonts took hold of the work.

On Mr. Shonts' arrival at the Isthmus, he found General Gorgas despondent because with the limited force at his command, about 200 men, he was making little progress in stamping out yellow fever. Mr. Shonts authorized Gorgas to put 2000 men at work in place of 200, with instructions to increase the number to 3000 or 4000, if necessary to carry the work of disinfection and cleaning to every house in Panama and Colon. It is stated that Mr. Shonts was also responsible for the order establishing commissary stores on the Isthmus to sell food and supplies to the employees at cost; and when informed that that would be a violation of an order of the War Department, he replied that it was so much the worse for the order.

A further idea of the general contents of the book may be gleaned from the titles of some of the chapters, as follows: Solving the Labor Problem; How the Lock Type of Canal Came to Be Chosen; Human Mosquitoes; M. Bunau-Varilla and the Revolution in Panama; Farewell to Mr. Stevens; Some Other Men Who Helped.

An appendix, entitled "A Triumph for the Engineering Profession," reprints the editorial in ENGINEERING NEWS of May 28, 1914, in which a comparison was made between the original estimate of the canal's cost and the actual cost figures for the completed work, showing, as our readers will remember, remarkably close agreement.

Mr. Pepperman has been very frank in his statements, and there will doubtless be those who will claim that a different distribution of credit should have been made. The period which the author covers, as noted above, practically ends in 1907, when the author's connection with the work ceased.

The author ascribes a large part of the failure of the first Isthmian Canal Commission to the adoption of the army and navy system of accounting; and he explains in detail the red tape and hampering requirements in connection with that system which made efficiency impossible. Under the "railroad régime" this cumbersome system of accounting was abolished, and apparently it was not restored when the army engineers were placed in control in 1907. If it is true that our army and navy were hampered by such cumbersome accounting methods that efficiency and prompt work were impossible in building the canal, then by all means the accounting system ought to be reformed for the sake of the army and navy itself. Present events in Europe prove that there is no department of the Government in which efficiency and prompt action are more essential to national life than in the organizations for national defense.

Paving in Europe

STREET PAVING AND MAINTENANCE IN EUROPEAN CITIES—A Report by Henry Welles Durham, Chief Engineer of the Bureau of Highways, Borough of Manhattan. New York City: Office of the President of the Borough of Manhattan. Cloth; 7x10 in.; pp. 437; 280 illustrations.

It would not be far amiss to describe this book as an encyclopedia of European paving practice, for such it very nearly is.

The book is divided into seven chapters, an appendix and charts. The chapters cover the paving practice of the principal cities of Great Britain, France, Germany, Austria, Belgium, Holland, Switzerland and Italy. In most instances, not only is the paving practice—methods, costs, labor rates, etc.—given, but many observations on allied subjects, such as the placing of fire hydrants, sewer inlets, street signs, advertising signs, and other street details. There is much statistical matter, but there are also many general observations and conclusions which make the book readable.

It is to the advantage of the reader that the author of this book went to Europe with the attitude of a student of highway practice rather than as a past master who sought only subjects for commendation or criticism. Evidently, instead of letting officials of the various cities show him their best pavements, as it is only natural to do, the author made many independent trips on his own responsibility; consequently, he has become familiar with much of the paving practice which the superficial and formal observer would be apt to overlook.

About half the book is devoted to an appendix which contains statistics, engineering reports, specifications, prices of labor, analyses of costs, etc., from the official reports of the principal European cities—London, Liverpool, Glasgow, Berlin, Hamburg, Paris, etc. All this material, to be sure, has appeared in print before, but it is scattered through many publications and is here brought together for the first time. Much of it, of course, was in foreign languages and unavailable to the average American reader. The compilation of specifications for paving in the various cities of itself forms a valuable reference work.

A good general idea of the character of the book may be drawn from the article in ENGINEERING NEWS of July 2, 1914, which is an abstract of the general conclusions in Chapter VII of Mr. Durham's report.

Machine-Shop Management

REVIEWED BY RALPH E. FLANDERS*

HANDBOOK OF MACHINE SHOP MANAGEMENT—By John H. Van Deventer, M. Am. Soc. M. E., Associate Editor "American Machinist." New York and London: McGraw-Hill Book Co., Inc. Flexible leather; 4x7 in.; pp. viii + 374; 244 illustrations. $5, net.

If scientific management proves to be a real science as its exponents have claimed, that science will have its books on data, on principles, and on practice, as well as mere descriptions of working examples. So far the literature has been mostly of the latter kind, interspersed with fragments of a more scientific character. Meanwhile, in the absence of any great quantity of fundamental literature, books like the one under review will be found interesting and valuable. It is logically arranged and carefully indexed, and from these standpoints alone it is a book worth having.

The general subject is treated under the following subdivisions, which, it will be seen, cover pretty completely the field of management: General Control; Design Control; Equipment Control; Quantity and Quality Control; Time and Cost Control; Traffic and Shipment Control; Shop Hazard Control.

The examples of methods and equipment are drawn from a very wide range, and are given in a condensed form, which makes them doubly valuable.

The author of the book is one of the editors of a well-known technical journal and has evidently drawn heavily on his files for the material used, though much new matter has also been added. Praise is due him for the way in which he has welded this material into a complete whole, giving a continuous, logical and thorough presentation of his subject, and leaving very few signs of the heterogeneous material of which it is composed. In this respect he may well serve as an example for other editors who have not been quite so successful in work of this kind.

THE OFFICIAL GOOD ROADS YEAR-BOOK OF THE UNITED STATES (1915)—Washington, D. C.: American Highway Association, Colorado Bldg. Cloth; 6x9 in.; pp. x + 498. $1, or $4 for five copies, postpaid.

The fourth edition of this annual contains the usual amount of data on the highway laws and organizations of the various states. In general, the subject matter is similar in character to that in previous issues. Some of it is the same, such as the chapter on the history of road building. A chapter on highway bridges and culverts gives the standard practice of the U. S. Office of Public Roads. The Massachusetts specifications for various types of road surfaces are included, as in the volume of last year, although these specifications have been brought up to date.

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Many departments have been added to, especially that on highway engineering education, which gives a list of all the technical schools and colleges of the United States that offer highway courses. The courses are described in considerable detail. It would be hard to improve upon this year-book, which deserves a place in the working library of every highway engineer.

Pumping for Irrigation

REVIEWED BY R. P. TEELE*

PRACTICAL IRRIGATION AND PUMPING; Water Requirements, Methods of Irrigation and Analyses of Cost and Profit—By Burton P. Fleming, Assoc. M. Am. Soc. C. E., Head of Department of Mechanical Engineering, State University of Iowa; formerly Irrigation Engineer, Office of Irrigation Investigations, U. S. Department of Agriculture. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. xvi + 226; 62 illustrations and diagrams. $2, net.

The title of this book is somewhat misleading in that "Practical Irrigation" is given first place in the title, while the book deals with irrigation practice only incidentally and as it relates to pumping. This, however, is a criticism of the title and not of the book itself, as Mr. Fleming has produced an unusually good combination of the practical and the theoretical in this discussion of pumping for irrigation.

The discussion is limited to the comparatively small pumping plants that are adapted to the needs of the individual farmer or a few neighbors and leaves out of consideration the large plants such as are used in the rice districts of the Gulf states, along the Rio Grande in Texas, and in a few other localities. The field for irrigation development by means of the small pumping plant is very large, since, as pointed out by Mr. Fleming, it is cheaper in many instances to pump water from streams than to construct, maintain and operate the long canals necessary to bring water to the same lands by gravity. In fact, it is the opinion of the author that in some cases pumping plants might be substituted for canals already built, with profit to their owners. Further than this, the great undeveloped and unused source of water for irrigation in the United States is the underground supply, most of which must be pumped. From both geological and mechanical considerations the small plant pumping water to the point where it is to be used is the most practicable unit. This relates to the well and pump. Whether the individual power unit or the central plant with electrically driven units is best depends entirely upon local conditions as to water-supply, fuel prices, etc.

Mr. Fleming's book is written for the man who is considering the installation of a small pumping plant. He tells him first how much water he should have for the the irrigation of various crops, how large a stream he should have to work economically, and the area which he can irrigate in a ten-hour day with streams of different sizes—all of which the man must know to decide intelligently how large a plant he should have. This constitutes the discussion of "practical irrigation."

The discussion of the occurrence and movement of underground water is unusual in that the author gives the theory quite fully and yet recognizes its limitations. Few writers who have gone into this subject fail to be carried away by the theory and put too much faith in formulas involving many factors, few if any of which can be accurately determined in practice. As Mr. Fleming puts it, these formulas are based on "conditions which seldom exist."

The discussion of wells and equipment shows the same combination of the theoretical and practical. The theories of capacity of wells, draw-down, etc., are discussed fully and are followed by practical directions as to sinking and curbing wells, and putting in casings and strainers. The various types of pumps and their strong and weak points and the conditions to which they are adapted are fully discussed, as are the types of motors, with practical discussions of all the details of bearings, drives, installation and operation.

The book contains a large number of diagrams and charts that make the text of much greater value to the man for whom the author wrote—the non-technical man who needs to know what to buy.

The book, as a whole, is typical of Mr. Fleming's work as an investigator and a teacher, with which the reviewer has been familiar for years, and shows a very unusual combination of theoretical knowledge and common sense.

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British Railway Track

MODERN BRITISH PERMANENT WAY; Treating of Rails, Chairs, Fishbolts, Fishplates, Keys, Sleepers, Ballast, Rail-Joints, Points and Crossings, Etc. By Cecil J. Allen, London: "The Railway News," 91 Temple Chambers, Temple Ave. Cloth; 8x10 in.; pp. xvii + 147; 50 illustrations. Six shillings, net.

Railway track in this country is so different from that in England that this book presents comparatively little of practical value to the American engineer. It is a good exposition of British practice, but deals entirely with material and has nothing to say regarding organization, construction or maintenance methods.

The chapter on rail design and manufacture shows the "standard" British double-head rail sections. The T-rail is credited to Charles Vignoles, 1836, but it was invented first in the United States by Robert L. Stevens (1830), who also designed the spike fastening and the splice joint. The author correctly ascribes the splice-bar to Stevens. It is rather surprising to find it stated that English railway engineers and railmakers have not paid sufficient attention "to the question of producing thoroughly sound steel."

British rail joints are spliced mainly with short and heavy flat fishplates and four bolts. The present rail length is usually 45 ft., though 60-ft. rails are in use. The cast-iron chairs which support the double-head rails are dealt with at considerable length. These weigh 40 to 55 lb. each, or 80 to 110 lb. of metal per tie. Wood or hollow steel wedges secure the rail in the chair, which is secured to the ties by bolts, round spikes, screw-spikes or trenails.

The "meager dimensions" of ties on American and Canadian railways are criticized. But the standard British ties are only 5 in. thick, though 10 in. wide and 9 ft. long, and are spaced about 30 to 34 in. c. to c. (24 in. at joints). Thus, the rails have less efficient support than American rails on ties 8 to 9 in. wide, 6 to 7 in. thick, 8½ ft. long, and spaced about 20 to 24 in. c. to c.

No reference is made to tie-plates (since T-rail track is not included), but there is mention of devices to prevent the creeping of rails. The ties are usually creosoted, but the details of treatment vary considerably on different roads. Of more interest is the description of the machines used for adzing and boring the ties, such

machines being used (as yet) to but a limited extent in this country.

With tracks spaced only 10 ft. 8½ in. c. to c. the width of double-track roadbed is 28 ft. in cuts and 30 to 33 ft. on banks. In cuts the ballast extends the full width between slopes, but on banks its base of heavy stone paving is only about 25 ft. wide. This leaves a wide berm on each side, instead of the narrow berm commonly seen on American railways.

The material thus far noted covers some 90 pages. The remaining 53 pages are devoted entirely to switches, frogs and crossings. The rigid frog is almost universal, though mention is made of a spring-rail frog. The use of manganese-steel for work of this kind is dealt with. The book is well printed and illustrated.

Elementary Drawing

REVIEWED BY ALTON L. SMITH*

ELEMENTARY MECHANICAL DRAWING; Theory and Practice, With Chapters on Geometical Drawing, Mensuration and Reproduction of Drawings: A Text-Book for Technical, Secondary, Trade and Vocational Schools—By Charles William Welck, Assistant Professor of Drawing and Design, Teachers' College, Columbia University. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. x + 250; 154 illustrations. $1.75, net.

As its title implies, this book is for the beginner in drafting. The first sixth of the text describes the various instruments and implements used in mechanical drawing and explains in great detail their manipulation and the methods used to secure the best results. Next there is a brief chapter on free-hand lettering, followed by another sixth of text on common drawing-room practice concerning kinds of drawings, significance of various lines, putting on dimensions, sections, shade lines and line shading. A short chapter on projection explains kinds and adaptation of the different methods of representation.

All this text is preliminary for two carefully graded series of 38 practice plates about equally divided between subjects suitable for woodworkers and those suitable for metal workers. Chapters on useful geometrical constructions, common computations of areas and volumes and the reproduction of drawings by the blueprint and the hectograph processes are also appended.

The book is not essentially different from others on the same subject. It is carefully written, well illustrated and contains a large amount of the information needed by the beginner. By its aid it would seem as if a boy of ordinary intelligence could pick up the work without the assistance of a teacher.

How to Drain Land

LAND DRAINAGE: A Treatise on the Design and Construction of Open and Closed Drains—J. L. Parsons. Chicago: The Myron C. Clark Publishing Co. London: E. & F. N. Spon, Ltd. Cloth; 6x9 in.; pp. xi + 165; 32 illustrations. $1.50.

In a straightforward manner and in small space the author has set forth the main principles and many of the details of land drainage. According to his preface, the book is designed for inexperienced drainage engineers, for drainage contractors, and for landowners. As regards experienced drainage engineers, the author makes no claim of service, but he modestly bespeaks "a careful analytical reading" of his pages in the hope that some of them "will be thus incited to take issue with or elaborate upon the questions discussed and thus aid in the formulation of better drainage standards."

After a short chapter on preliminary surveys, the author takes up the design of tile drains and their outlet walls and their inlets. He then discusses the design and maintenance of open drains, plans, reports and records, and cost estimates. Then follows a chapter on specifications, their preparation and enforcement. The treatment here is suggestive rather than exact. General model sections are presented, interspersed with comment. Assessments of drainage costs on property benefited is treated in an unusual but helpful way. The last chapter is on the quality and inspection of tile. A short appendix contains instructions by a judge to a jury charged with awarding damages to landowners on account of a drainage ditch; bidding and contract forms, and a tabular "Historical Record of Representative Tile Drains."

A number of useful tables are given. Illustrations are used with discretion. The mathematical discussions are simple and short.

Altogether the volume seems well designed and well executed to meet the needs of classes of users mentioned in the first paragraph of this review.

Sewage-Treatment Methods

SEWAGE PURIFICATION AND DISPOSAL—By G. Bertram Kershaw, M. Am. Soc. C. E., Engineer to the Royal Commission on Sewage Disposal. New York: G. P. Putnam's Sons. Cambridge, England: The University Press. (Cambridge Public Health Series.) Cloth; 6x9 in.; pp. x + 340; 56 illustrations. $3.75.

Sixteen years' service as Engineer to the Royal Commission on Sewage Disposal should go far toward fitting a man to summarize current practice in sewage treatment—a task which the present author has attempted and successfully accomplished.

After three chapters dealing with conservancy methods, sewage composition and volume, the author takes up the removal of suspended matter (grit chambers, screens and tanks), sludge disposal, land treatment, contact beds, percolating filters, sterilization, and trade wastes. Three indexes—subject, author and place—are provided.

The work is useful, not so much because it contains many new facts as because it is the latest comprehensive review of the subject by one well informed on its broader aspects and many details, and also because, besides epitomizing the best of the voluminous contents of the reports of the Royal Commission, it takes into account both American and German studies and practice.

A moderate use of well-chosen illustrations adds to the value of the book. Although the line engravings are always legible, much better results would have been obtained in many cases had the line work and lettering been rendered with more regard to the demands of photo-engraving reduction. In fact, with good draftsmanship some of the illustrations which now appear on folding plates could have been reduced to go in the page text, and with better effect.

MASONRY: A Short Text-Book on Masonry Construction, Including Descriptions of the Materials Used, their Preparation and Arrangement in Structures—By Malverd A. Howe, M. Am. Soc. C. E., Professor of Civil Engineering, Rose Polytechnic Institute. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. ix + 160; 115 illustrations. $2, net.

There are several, though no quite uptodate, books on masonry construction which undertake to treat the whole

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subject in a comprehensive fashion. In many ways a new book of this type would be welcome. Professor Howe's book, however, is acknowledged to be only an elementary treatise "for use as a text in courses of instruction which do not provide sufficient time for the study of a more comprehensive treatise."

The book is admirably suited to serve such purpose. It is concise and, so far as it goes, quite complete. It appears to have very little use beyond the classroom.

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A Translation of Melan's Concrete Arches

REVIEWED BY LEON S. MOISSEIFF*

PLAIN AND REINFORCED CONCRETE ARCHES—By J. Melan (Kaiserlicher-Königlicher Hofrat), Professor of Bridge Design of the German Technical School at Prague. Authorized translation by D. B. Steinman, Professor of Civil Engineering, University of Idaho. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. x + 161; 43 illustrations. $2, net.

Professor Melan's monograph on the theory of arches, with special consideration of reinforced-concrete arches, has formed part of the Handbuch für Eisenbetonbau for some time and was well known to engineers familiar with German engineering literature as an excellent treatise on the subject. It has now found an able translator and thus has been made accessible to American and English engineers. Concrete arches are nowadays of common occurrence and form part of the regular routine of structural engineers. It is, therefore, a great convenience to have at hand a book giving in full complete methods for the computation of solid arches. Given a knowledge of calculus and mechanics, which is universally taught in our engineering schools, Professor Melan's treatment is clear and easily followed.

After discussing the forces acting on an arch and the internal stresses caused by them in a direct and concise manner, a short analysis of the three-hinged arch is given. The author then attacks the more important and also the more serious problem of the hingeless arch. Both an analytic and a graphic method are given. The former method is thorough and quite universal in its application. The author determines the unknown quantities due to the statical indeterminateness of the arch from its assumed elastic qualities with the aid of Castigliano's theorem, or, as it is more generally known, the principle of least work. This is mentioned all too hastily without any explanation of its derivation or meaning. In a chapter of a big encyclopedic work of reference as the Handbuch für Eisenbetonbau such treatment may be proper, but in a separate book on arches its information is too meager. A note by the translator explaining and deriving to some extent Castigliano's theorem would be here well in place.

The graphic method is deduced by means of the equations of condition for the deflection of curved ribs. It is complete and will probably give very close results. It may, however, be mentioned here that the graphic method well known in this country as the Cain-Thatcher method furnishes as accurate results as rigid practice would wish for. In the case of an arch of long span the reviewer computed the stresses by this method and also by the analytical method given in this book by Professor Melan. In view of the importance of the work, and also to obtain a fair comparison of the accuracy of the Cain-Thatcher method, all the lines were plotted by computed coördinates. The results were so close to each other that the reviewer feels satisfied of the practical sufficiency of that method.

It is true that the effect of shearing stresses on the elastic work of deformation is negligible. The reviewer feels, however, that in as complete a work as the one discussed it should be shown how to include their effect, be it merely for verifying the accuracy of this assumption. Engineering assumptions with time are taken as truisms and their verifications sometimes result in seriously shaking their authority. The short chapter on "Approximate Methods for the Hingeless Arch" is excellent. The author further deduces the equations for two- and one-hinged arches and arches continuous over several spans. The pages devoted to assumptions and formulas for determining the best curve for an arch and its thickness are good and suggestful. The author also gives two fully worked out numerical examples of bridges computed, one by the analytical method and the other by the graphic. They furnish a good illustration of the procedure to be followed and the amount of work required.

The book will prove useful to the designing engineer, and the translator has rendered good service to the profession by rendering it into English.

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Protection of Steel Structures from Corrosion

Reprints of a recent paper presented by F. H. Fay, of Fay, Spofford & Thorndike, Boston, before the Engineers Society of Western Pennsylvania are being offered for free distribution to engineers by the National Lead Co., 111 Broadway, New York City. The paper describes the woeful condition of certain bridges in Boston under the lax maintenance of a politically dominated department and outlines the use of mass concrete protective coverings. The discussion of the paper includes, among other contributions, an exposition of good painting practice by Prof. A. H. Sabin, of New York.

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A Spanish Trautwine

MANUAL DEL INGENIERO—Por John C. Trautwine, Revisado por John C. Trautwine, Jr. y John C. Trautwine, 3d. Traducido de la 19a edicion (1913) y convertido al Sistema Metrico por A. Smith, Ingeniero Civil, Profesor de la Universidad Central de Caracas, Ex-Presidente de la Facultad de Ciencias Exactas. Paris: Casa Editorial Garnier Hermanos. [For sale in the United States by A. Smith, Technical Bureau, 45 Broadway, New York City; the Trautwine Co., 257 South Fourth St., Philadelphia, Penn.] Flexible leather; 5x7 in.; pp. 1273; illustrated. American price, $5, net.

The rapid increase of engineering work in Spanish-speaking countries, particularly in South America, and the similar increase in the number of native engineers engaged in that work make it quite probable that this new translation of the standard American handbook will have a large sale. The preface states that the translation has been as literal as the two languages will permit, and the formulas and tables have been printed side by side in both English and metric systems. In typography and appearance the Spanish Trautwine closely resembles its English prototype. Its wide use in South American countries should tend to promote a closer relationship between the engineering of those countries and that of the United States, for at present Spanish-speaking countries have to look largely to French and German books for their translations and text-books.

Stamp Milling and Cyaniding

REVIEWED BY F. W. TRAPHAGEN*

STAMP MILLING AND CYANIDING—By Francis Andrew Thomson, Head of Department of Mining Engineering, State College of Washington, Pullman, Wash. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xi + 285; 118 illustrations. $3, net.

Professor Thomson has presented in this book an excellent review of current metallurgical practice in amalgamation and cyanidation. The subject is covered in a logical way, the facts tersely, yet fully, presented and the illustrations are exceptionally well selected. Underlying principles are discussed in a masterly way, and methods in use are described by reference to methods in vogue at our most uptodate plants.

The flow sheets giving at a glance the sequence of operations are exceptionally good and acceptable because many of the details of practice are shown thereon and in nearly all instances costs of operations are also given.

The table (Table 14) giving "characteristics of various slime-filtering devices" is especially good.

A very full bibliography is given at the end of each of the 15 chapters, and numerous references accompany the text. In makeup the book is very pleasing, and typographical errors appear to have been reduced to a minimum.

As a text-book for classes in metallurgy, Thomson's book should prove a welcome addition to teachers of this subject, and its adoption for this purpose may be confidently expected.

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A "List of References on Municipal Accounting," compiled under the direction of H. H. B. Meyer, Chief Bibliographer, Library of Congress, with the coöperation of various other libraries, occupies 13 pages of *Special Libraries* for March. (Indianapolis, Ind.; 25c. per number.)

NEW PUBLICATIONS

[So far as possible the name of each publisher or books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale, and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to theauthor or other person indicated in the notice.]

AMERICAN WOOD PRESERVERS' ASSOCIATION—Proceedings of Annual Meeting held at Chicago, Ill., Jan. 19-21, 1915. Baltimore, Md. (Mt. Royal Station): F. J. Angier, Secretary. Paper; 6x9 in.; pp. 527.

ANNUAL REPORT OF THE SECRETARY OF THE MICHIGAN STATE BOARD OF HEALTH FOR 1913—Lansing, Mich. Cloth; 6x9 in.; pp. 183; illustrated.

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DISPLAY WINDOW LIGHTING AND THE CITY BEAUTIFUL: Facts and New Ideas for Progressive Merchants —By F. Laurent Godinez, Consulting Lighting Specialist; Member, Jersey City Chamber of Commerce; author of "The Lighting Book," "What Do We Know About Lighting?", "Light on Decoration," etc. New York: The Wm. T. Comstock Co. Cloth; 6x9 in.; pp. 222; 114 illustrations. $2, net.

DISTRICT HEATING: A Brief Exposition of the Development of District Heating and Its Position Among Public Utilities—By S. Morgan Bushnell, M. Am. Inst. E. E., Past President, National District Heating Association, and Fred B. Orr, Commercial Engineer, Illinois Maintenance Co. New York: Heating and Ventilating Magazine Co. Cloth; 6x9 in.; pp. ix + 290; 82 illustrations. $3, net.

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HINTS CONCERNING THE ORGANIZATION OF WORKSHOPS AND FACTORIES—By Robert Grimshaw, Consulting Engineer; Lecturer, New York University School of Commerce, Accounts and Finance, Pratt Institute, etc.; author of "Catechisms of Locomotive and Stationary Steam Engines, Boilers and Pumps"; "Shop Kinks"; "Workshop Practice"; "Werkstatt Betrieb und Organization"; "System und Organization in kaufmaennischen Betrieben," and other practical works in English, French and German. New York: New York University Book Store, University Bldg., 32 Waverly Place. 4x6 in.; pp. 104. 50c.

HUMAN NATURE AND RAILROADS—By Ivy L. Lee. Philadelphia: E. S. Nash & Co. Cloth; 5x8 in.; pp. 129. $1, net.

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REPORT OF THE EFFICIENCY AND ECONOMY COMMITTEE Created under the Authority of the 48th General Assembly of the State of Illinois, and a Report on State Administration of Public Works, Parks and Buildngs, Prepared for the Committee by C. O. Gardner. Urbana, Ill. (University of Illinois): Prof. John A. Fairlie, Director of the Committee. Paper; 6x9 in.; pp. 80 and 113; illustrated by charts.

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SURVEYING AND BUILDING CONSTRUCTION for Agricultural Students, Land Agents and Farmers—By A. H. Haines, Head of the Estate Management Department and Lecturer in Surveying at the South Eastern Agricultural College, Wye, Kent, England; Member of the Board of Studies in Agriculture of London University, and A. F. Hood Daniel, Lecturer in Building Construction at the South Eastern Agricultural College. New York and London: Longmans, Green & Co. Cloth; 6x9 in.; pp. xiii + 339; 222 illustrations. $3, net.

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No. 341: Underground Waters of the Coastal Plain of Georgia—By L. W. Stephenson and J. O. Veatch, and a Discussion of the Quality of the Waters by R. B. Dole. Pp. 539.

No. 343: Geology and Water Resources of Tularosa Basin, New Mexico—By O. E. Meinzer and R. F. Hare. Pp. 317.

No. 353: Surface Water Supply of the United States, 1913: Part III, Ohio River Basin—By A. H. Horton, W. E. Hall and H. J. Jackson. Pp. 264.

No. 354: Surface Water Supply of the United States, 1913: Part IV, St. Lawrence River Basin—By N. C. Grover, Chief Hydraulic Engineer; W. G. Hoyt, A. H. Horton and C. C. Covert, District Engineer. Pp 136.

No. 365: Ground Water in Southeastern Nevada—By Everett Carpenter. Pp. 86.

No. 375-A: Ground Water for Irrigation in the Sacramento Valley, California—By Kirk Bryan. Pp. 49.

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*Professor of Metallurgy and Assaying, Colorado School of Mines, Golden, Colo.

Field and Office

Foundations for High Towers at Darien

By Ira W. Dye*

The most difficult element in the construction of three 600-ft. self-supporting steel radio towers at Darien, C. Z., was probably the foundations. This was due to their

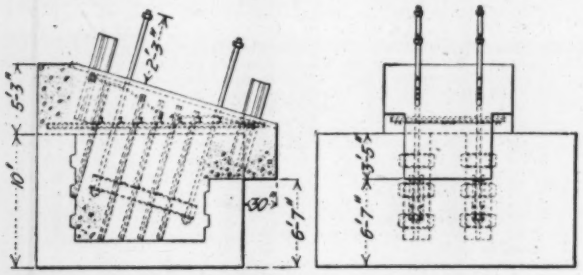


Fig. 1. Design of Tower Footings at Darien

large size (20x16 ft. in plan by 12 ft. deep) and the extensive grillage system which they include. The grillage steel or the "irons" had to be set at the correct inclination before concreting could commence.

The footings of each tower are at the points of an equilateral triangle 150 ft. on a side. In attempting to locate the foundations on the tops of the hills, however, it was found that the line of reaction (about 16 deg. off the vertical) of the foundations in some cases would have been so nearly parallel to the natural slope of the ground that it was not considered safe to build the foundations in that way. They were accordingly located so that each foundation or footing has a solid bank of undisturbed material behind it (Fig. 4). All but two exert their pressures into, rather than along, the slope of the knolls on which they are located.

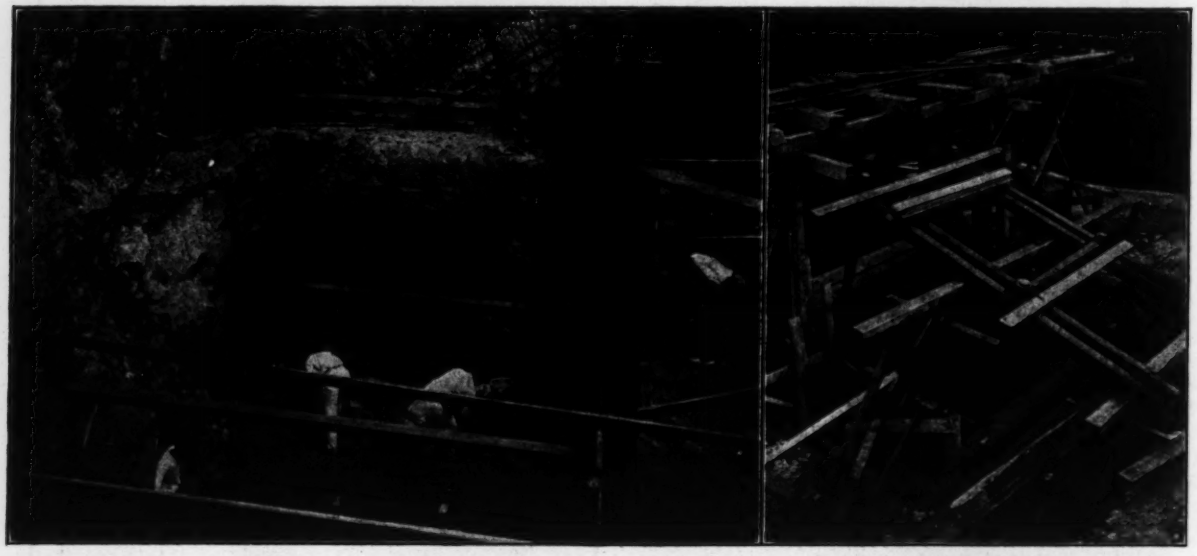
*Former Supervisor of Radio Stations, Panama Canal, C. Z.

Soil

The preliminary locations having been selected, test pits 4 ft. square were sunk at various places to determine the character of the subsoil. At towers 1 and 2 the soil was found to be a hard clayey marl. This material when undisturbed and confined in its original location and not subjected to the action of water seemed capable of resisting very high pressures. At the site for tower 3 a similar stratum was discovered underlaid by a broken bed of rather soft limestone or tufa, numerous limestone boulders occurring even near the surface of the ground. The site of No. 3 is in the outskirts of an area which at one time was considered as a possible source of limestone to be used in a projected cement mill for furnishing cement for the locks, spillways and other Canal work. The plant was not built; but in the investigations of its feasibility the existence of this bed of limestone was disclosed. This material provided excellent bearing, no piling or subfoundation supports being necessary.

The Foundations

The type of foundation adopted was developed on the Isthmus after a study of local conditions and of the reactions from the tower. Fig. 1 shows the design. The excavation work was done entirely by hand, soil being disposed of in the immediate neighborhood of the foundations by means of wheelbarrows, and in some cases by half-yard narrow-gage dump cars.



Figs. 2 and 3. (Left) Excavating for Footing. (Right) Fixed Irons for Core Held in Place by Falsework before Concreting

Earth slides in several of the foundation pits during excavation caused trouble. As it was considered very important that no surface water should enter between the walls of the pit and the concrete of the foundation, no forms were built in the pits except as required to produce the dividing line between shell and core; otherwise the concrete was allowed to fill all irregularities left by slides. This resulted in greatly increasing the amount of concrete placed, but was necessary, because this marl disintegrates rapidly on exposure to water.

Loads—The maximum calculated downward thrust due to the combined dead load, wind load and antenna pull is 759,000 lb. per leg; the maximum upward pull is 400,000 lb. These loads are applied at an angle of 16 deg 6 min. 7 sec. from the vertical at a point considerably above the center of gravity in the foundation. To be certain that the entire foundation would act as a unit in resisting thrusts and pulls, both shell and core were reinforced with old rails. The total weight of these rails in the shell of a footing is about 12,000 lb. The grillage system includes some heavy anchorage beams, to which the lower ends of the anchor bolts are connected, and certain I-beam posts which extend through the top of the core masonry for the purpose of supporting part of the insulators surrounding the base of the tower. All these fixed irons in the core were mounted at angles with the horizontal corresponding to the inclination of the lower section of the tower leg, and their total weight is about 11,000 lb. per footing.

FIG. 4. TYPICAL FOOTING SITE
(Note sloping earth at rear)

Supporting in correct alignment and at an exact grade this heavy mass of iron while the concrete was being poured around them constituted the most trying and difficult piece of work in the building of the entire station. The complicated nature of the falsework used to support and align the anchor bolts and I-beams is shown in Fig. 3.

Each footing was adjusted independent of the other two of the same tower. Reference points on the line of thrust and on lines perpendicular to it were set before excavation began and were frequently rechecked. In placing the falsework the engineer set points on the finished shell masonry, from which the supporting beams and posts were aligned by the form carpenters. The irons were then lowered into the pit and placed approximately in their proper position. The necessary forms were built and guy wires with turnbuckles and improvised jacks made from ¾-in. bolts with an extra-long thread were placed to allow slight movement of any part of the iron work by taking up or slacking out. Enough of these turnbuckles and jacks were placed so that each anchor bolt could be moved in any direction, both at its lower end and at a point just below the plane of the finished face of the masonry. The same was done as regards the four built-up I-beam posts.

The final alignment was done by the engineer, who used three transits, one on the line of thrust and another on a line perpendicular to this through the top of each pair of anchor bolts. At the same time a wye level was set up at a convenient point, so that any changes in the position of the anchor bolts could be adjusted as to elevation before they were finally guyed into place. Deflection of the fixed irons was seldom more than ½ in. One-half day's work for the engineer, two transitmen and four or five negro carpenters and helpers was required to align and anchor the fixed irons ready for the placing of concrete.

Concrete—The concrete was a 1:2½:5 mixture of portland cement, sea sand and crushed trap rock. The latter was of the same quality as that used in the Pacific locks of the Canal and came from Ancon Hill. It is hard and black, and was crushed to sizes passing a 4-in. ring, the smaller sizes not being screened out.

Increasing Motor-Truck Efficiency

The motor truck is here to stay, but probably only a small percentage of owners have made careful and complete study of its problems. More use motor vehicles for quick than for efficient service. The efficiency of a truck depends on (1) the truck's ability, (2) working conditions, and (3) operating administration. Definite rules may govern the first and last factors; the second demands individual study.

In investigating ability the prospective purchaser should consider whether a truck has been produced as the result of long experience and careful design, by an organization seeking quality and appreciating the need of service to the customer. To study administration, the owner should have an accurate record of complete operations, including full time figures on each truck in service, out of service, running loaded, running light, loading and unloading, as well as distances covered, operating conditions, operating costs, amortization, interest, insurance and other overhead charges.

Under working conditions there are many points involved. The average truck owner does not give sufficient attention to the driver. A truck works under severe conditions, varying loads and rapid changes of speed, so that it is entitled to proportionally as much care and attention as a locomotive. It can be ruined in a day or with careful handling will last for years. Plenty of lubrication, sufficient cooling water and care in taking up the wear on the various parts are needed. The intelligence, energy and skill of the driver, therefore, are very important items. The manufacturer's agent should give the driver full instructions and see that they are obeyed. The employer should allow the driver time to give his truck the attention needed.

A truck to be efficient must be kept running and working up to capacity; although the cost per mile of the truck kept running is greater, the cost per ton-mile is less. To develop maximum capacity careful attention

is necessary to the shipping facilities. Accessibility is of prime importance. Position of building, restriction of room, city regulations about blocking sidewalks, etc., should receive careful study. Some stores use nest bodies, loading up crates on the shipping platform and transferring to the truck. Lumber dealers use yard (horse) trucks and slings for collecting and transferring a load to the truck. Breweries have conveyors to take out empty kegs and deposit full ones in the truck body.

There are uncontrollable local conditions which may make the difference between efficient and inefficient operation; but attention may avoid them. A heavy truck sent on a short trip may be useless for the rest of the day because there is not time left for a long trip and it may be held up until the next day. While there are exceptions, yet as a rule it is best to keep the heavy trucks hauling long distances and let light vehicles or horses handle the business close at hand.

Too few operators give a proper amount of thought to the routing of their trucks. Bad pavements, traffic congestions, short corners, necessity for backing, grades, etc., cannot be controlled, but they can be avoided. Some transportation managers have a map before them at all times and spend certain hours investigating street conditions, so they can direct drivers as to which thoroughfares to avoid and which to use.

The average operator overlooks backing, which takes time and is often hard on a truck. Side-opening bodies and thoughtful drivers will help. Grades should be avoided, but where impossible choose a cobble street for the ascent and a smooth pavement for the descent. Drivers should drop back to a lower gear for the hills as being easier on the motor, tires and entire car.

Snow and mud present conditions oftentimes fatal to truck operation. It is a case of getting sufficient adhesion. Keeping a truck heavily loaded will overcome the snow problem, but no remedy has been discovered for the effect of bad mud holes.

A fair schedule should be fixed and the driver kept to it. The receiver as well as the shipper should study trucking conditions.

The trucking problem is not an intricate one. It merely requires common sense, but it is becoming more and more important.—M. T. Rogers, of the Packard Motor Car Co., New York City, in the "Technology Monthly and Harvard Engineering Journal," May, 1915.

Laying New Track under an Old Elevated Railway Platform

Third-tracking the elevated railways throughout New York City has developed many interesting problems. How to build new structure and track under an existing side platform, with only 3 ft. 7 in. clearance, when it was impossible to place any falsework on the street below to block the platform off the main structure, was one of these problems. At the 149th Street Station on Third Ave. the local tracks had to be relocated 10 ft. farther out on each side, to provide room for the new center express track. To make way for the locals, the existing side platform was moved inward 9 ft. so that it became part of an existing center platform, which was later entirely removed, to meet the new express conditions.

Where possible during this work the platforms were supported on falsework built up from the street, but in the case of eight bents the proximity of surface tracks under one of the platforms made it impossible to use the street for this purpose. To meet this condition the contractor (Snare & Triest Co.) worked out the scheme illustrated herewith.

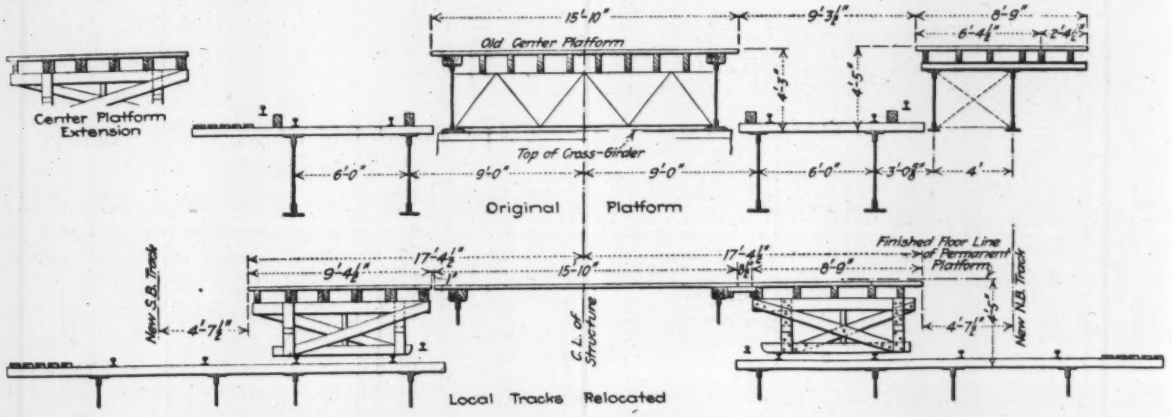


Fig. 1. Before and After Laying New Local Tracks at 149th St. Station, New York City

First, two 24-in. I-beams were hung transversely by steel-rod hangers from the existing track stringers, about 4 ft. to either side of a cross-girder. These beams cantilevered out beyond the existing tracks, and on this projecting portion a wood bent was placed to support the platform girders. The temporary I-beams and timber falsework in position are shown in Operation A (Fig. 2).

The platform to be moved is 262 ft. long by 8 ft. 9 in. wide and is carried on seven pairs of lattice girders of 40-ft. span each. These girders were supported on brackets projecting from the main cross-girders of the elevated structure. As soon as the falsework described had taken the load off these brackets, the latter were removed. New extensions to the cross-girders were then placed, and longitudinal stringers for the new track were framed between them.

Before new track could be laid, it was necessary to remove platform supports, leaving only the joists and floor in place. The supports consisted of six spans about 40 ft. long, each composed of a pair of latticed girders, with platform beams and canopies. The platform deck was temporarily supported on wooden bents resting on cross-

timbers placed on the bottom flanges of the new track stringers and so spaced as not to interfere with existing platform steel and proper spacing of track ties, as illustrated in Operation B.

After the platform steel had been removed and the track laid, wood frames were placed about six feet apart to support the platform deck. These frames rested on top of rail and were designed to slide across tracks on slide-sills (Detail D) placed between rails, as illustrated by Operation C.

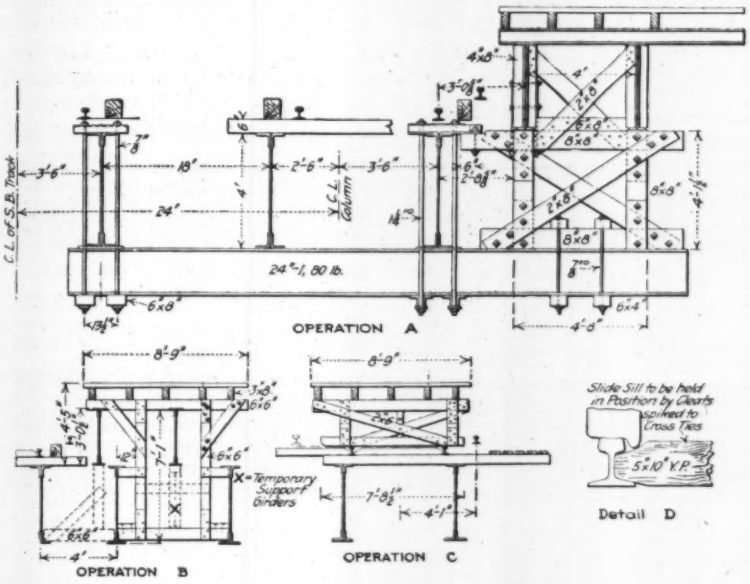


FIG. 2. METHODS OF SUPPORTING SIDE PLATFORM DURING LAYING OF NEW TRACK DIRECTLY BENEATH

In order to move the platform to the new position, hand-crabs were placed near cross-girder points and lines from the sliding frames were run to tackle blocks attached to center platform girders; then the entire platform was moved west 9 ft. in one operation. The new local track was then put in operation. This platform was later removed in small sections and replaced by an entirely new island platform.

Jacking Out Sheetpiles with a Friction Clamp

The west shaft for the Newark Bay deep tunnel of the Passaic Valley sewer was sunk inside a 34x27-ft. sheeted inclosure. Heavy-weight steel sheeting was used for the inclosure. Going about 40 ft. to rock, it was driven in two 32-ft. lengths spliced together by a butt splice with cover plates. After the concrete shaft had been built inside the shaft it became necessary to pull the sheeting and redrive it to form a larger well for building a flushing chamber alongside the shaft.

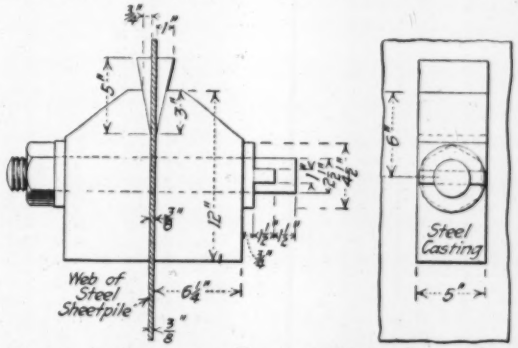
Hydraulic jacks are being used to pull the sheeting. On either side of the sheetpile wall, blocking is placed close against the pile to be pulled and a 50-ton jack is set on either side. A block or strut resting on top of the jack extends up to near the top of the pile and there bears against clamping blocks fastened to the head of the pile. This clamp arrangement is a novel device; it enables a very powerful lifting pull to be applied to the pile.

There is a 2½-in. hole through the web of the pile near the top. The lift that could be applied to this hole by a pin put through it would probably not exceed 20 tons without tearing out the hole, whereas a force several times as great is required to pull the pile. A pair of clamp blocks was therefore devised, with provision for gripping the web of the pile between the roughened faces of a pair of wedges. The arrangement is shown in the sketch herewith. The blocks are placed and clamped tight by the bolt through the pinhole; then the two wedges, the rear faces of which are scored, are driven into wedge recesses in the top of the blocks.

This gripping clamp proved amply powerful to take the 100-ton lift of the two jacks, as is known from the fact that one or two piles could not be budged by the jacks at full lift, although the grips did not slip, as shown by the scoring left by the backs of the wedges when the clamp was removed.

With this jacking rig for pulling the piles a crew of five men and foreman took as much as eight hours (in a moderately hard case) to pull one pile. This would give a labor cost alone exceeding $12, to which must be added the cost chargeable to the jacks and blocks, overhead charges, and a charge for occasional derrick service.

R. H. Keays is Engineer in charge of the whole tunnel for the contractor (New York & New Jersey Construction Co., of Newark) and R. E. Parker is superintendent of the west shaft, with F. R. McDonnell as Engineer.



GRIPPING-CLAMP FOR PULLING STEEL SHEETING

(New York & New Jersey Construction Co., Newark shaft of Newark Bay tunnel, Passaic Valley sewer)

A Steel Flat-Car for Whales has been built for the South African Rys. by the Leeds Forge Co., of Leeds, England. As described in London "Engineering" of May 7, the car has a capacity of 160,000 lb., and the weight of the car itself is 74,700 lb. The most remarkable thing about the car is that although it is designed to run on a narrow-gage road of 3 ft. 6-in. gage, the width of the car body is 12 ft. 6¼ in. The whales are brought to port near Durban, South Africa, and are loaded on these special cars for haulage to a factory a few miles away, where they are cut up for rendering. It is evident that cars of such extraordinary width could not run in general traffic on account of clearance limits, even on American standard-gage lines. Their use on a narrow-gage road shows the possibilities in increasing the width of rolling stock where clearance restrictions do not apply.

Table of Circular and Horseshoe Conduit Sections

A considerable improvement on existing hydraulic tables is represented by two tables which George Henry Ellis, Fort Shaw, Mont., has computed. They apply to circular and horseshoe conduit sections, and give the hydraulic properties for various depths of flow, *independent of any particular flow formula or coefficient.* For each hundredth of full depth the tables give the area, the wetted perimeter and the hydraulic radius. Any flow formula may be used.

Swan & Horton's "Hydraulic Diagrams" contains diagrams giving area, discharge and velocity for different depths of flow in circular conduits and in various forms of horseshoe and basket-handle conduit. The discharge and velocity values are of course limited to a particular formula for flow. Tables of areas of circular segments and the like are found in a number of books. The present tables give not only areas, but also the hydraulic

AREA, WETTED PERIMETER, AND HYDRAULIC RADIUS OF CIRCULAR AND HORSESHOE CONDUITS

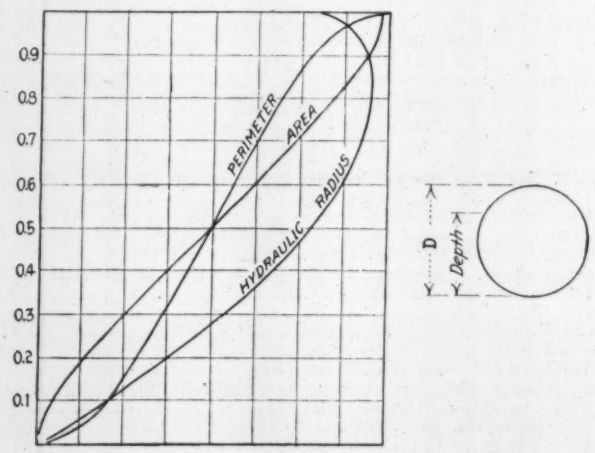
Computed to four decimals, for each 1% of depth.

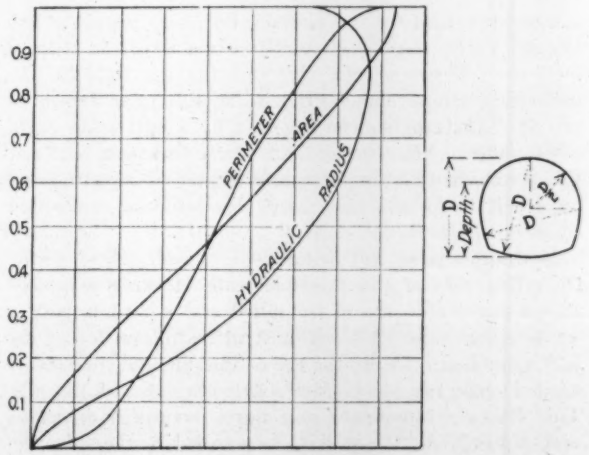
Circular Conduits

Depth (in terms of diameter)	Area (in terms of square of diameter)	Wetted Perimeter (in terms of diameter)	Hydraulic Radius (in terms of diameter)	Depth (in terms of diameter)	Area (in terms of square of diameter)	Wetted Perimeter (in terms of diameter)	Hydraulic Radius (in terms of diameter)
0.01	0.0013	0.2003	0.0066	0.51	0.4027	1.5908	0.2531
0.02	0.0037	0.2838	0.0132	0.52	0.4127	1.6108	0.2561
0.03	0.0069	0.3482	0.0197	0.53	0.4227	1.6308	0.2591
0.04	0.0105	0.4027	0.0262	0.54	0.4327	1.6509	0.2620
0.05	0.0147	0.4510	0.0326	0.55	0.4426	1.6710	0.2649
0.06	0.0192	0.4949	0.0389	0.56	0.4526	1.6911	0.2676
0.07	0.0242	0.5355	0.0451	0.57	0.4625	1.7113	0.2703
0.08	0.0294	0.5735	0.0513	0.58	0.4723	1.7315	0.2728
0.09	0.0350	0.6094	0.0574	0.59	0.4822	1.7518	0.2753
0.10	0.0409	0.6435	0.0635	0.60	0.4920	1.7722	0.2776
0.11	0.0470	0.6761	0.0695	0.61	0.5018	1.7926	0.2797
0.12	0.0534	0.7075	0.0754	0.62	0.5115	1.8132	0.2818
0.13	0.0600	0.7377	0.0813	0.63	0.5212	1.8338	0.2839
0.14	0.0668	0.7670	0.0871	0.64	0.5308	1.8546	0.2860
0.15	0.0739	0.7954	0.0929	0.65	0.5404	1.8755	0.2881
0.16	0.0811	0.8230	0.0986	0.66	0.5499	1.8965	0.2899
0.17	0.0885	0.8500	0.1042	0.67	0.5594	1.9177	0.2917
0.18	0.0961	0.8763	0.1097	0.68	0.5687	1.9391	0.2935
0.19	0.1039	0.9020	0.1152	0.69	0.5780	1.9606	0.2950
0.20	0.1118	0.9273	0.1206	0.70	0.5872	1.9823	0.2962
0.21	0.1199	0.9521	0.1259	0.71	0.5964	2.0042	0.2973
0.22	0.1281	0.9764	0.1312	0.72	0.6054	2.0264	0.2984
0.23	0.1365	1.0003	0.1364	0.73	0.6143	2.0488	0.2995
0.24	0.1449	1.0239	0.1416	0.74	0.6231	2.0714	0.3006
0.25	0.1535	1.0472	0.1466	0.75	0.6318	2.0944	0.3017
0.26	0.1623	1.0701	0.1516	0.76	0.6404	2.1176	0.3025
0.27	0.1711	1.0928	0.1566	0.77	0.6489	2.1412	0.3032
0.28	0.1800	1.1152	0.1614	0.78	0.6573	2.1652	0.3037
0.29	0.1890	1.1373	0.1662	0.79	0.6655	2.1895	0.3040
0.30	0.1982	1.1593	0.1709	0.80	0.6736	2.2143	0.3042
0.31	0.2074	1.1810	0.1755	0.81	0.6815	2.2395	0.3044
0.32	0.2167	1.2025	0.1801	0.82	0.6893	2.2653	0.3043
0.33	0.2260	1.2239	0.1848	0.83	0.6969	2.2916	0.3041
0.34	0.2355	1.2451	0.1891	0.84	0.7043	2.3186	0.3038
0.35	0.2450	1.2661	0.1935	0.85	0.7115	2.3462	0.3033
0.36	0.2546	1.2870	0.1978	0.86	0.7186	2.3746	0.3026
0.37	0.2642	1.3078	0.2020	0.87	0.7254	2.4038	0.3017
0.38	0.2739	1.3284	0.2061	0.88	0.7320	2.4341	0.3008
0.39	0.2836	1.3490	0.2102	0.89	0.7384	2.4655	0.2996
0.40	0.2934	1.3694	0.2142	0.90	0.7445	2.4981	0.2980
0.41	0.3032	1.3898	0.2181	0.91	0.7504	2.5322	0.2963
0.42	0.3130	1.4101	0.2220	0.92	0.7560	2.5681	0.2944
0.43	0.3229	1.4303	0.2257	0.93	0.7612	2.6061	0.2922
0.44	0.3328	1.4505	0.2294	0.94	0.7662	2.6467	0.2896
0.45	0.3428	1.4706	0.2331	0.95	0.7707	2.6906	0.2864
0.46	0.3527	1.4907	0.2366	0.96	0.7749	2.7389	0.2830
0.47	0.3627	1.5108	0.2400	0.97	0.7785	2.7934	0.2787
0.48	0.3727	1.5308	0.2434	0.98	0.7816	2.8578	0.2735
0.49	0.3827	1.5508	0.2467	0.99	0.7841	2.9412	0.2665
0.50	0.3927	1.5708	0.2500	1.00	0.7854	3.1416	0.2500

Horseshoe Conduits

Depth (in terms of diameter)	Area (in terms of square of diameter)	Wetted Perimeter (in terms of diameter)	Hydraulic Radius (in terms of diameter)	Depth (in terms of diameter)	Area (in terms of square of diameter)	Wetted Perimeter (in terms of diameter)	Hydraulic Radius (in terms of diameter)
0.01	0.0019	0.2830	0.0066	0.51	0.4466	1.7162	0.2602
0.02	0.0053	0.4006	0.0132	0.52	0.4566	1.7362	0.2630
0.03	0.0097	0.4911	0.0198	0.53	0.4666	1.7562	0.2657
0.04	0.0150	0.5676	0.0264	0.54	0.4766	1.7763	0.2683
0.05	0.0209	0.6351	0.0329	0.55	0.4865	1.7964	0.2707
0.06	0.0275	0.6963	0.0394	0.56	0.4965	1.8165	0.2733
0.07	0.0346	0.7528	0.0459	0.57	0.5064	1.8367	0.2757
0.08	0.0421	0.8054	0.0524	0.58	0.5163	1.8569	0.2781
0.0886	0.0491	0.8482	0.0578	0.59	0.5261	1.8772	0.2804
0.09	0.0502	0.8513	0.0590	0.60	0.5359	1.8976	0.2824
0.10	0.0585	0.8732	0.0670	0.61	0.5457	1.9180	0.2844
0.11	0.0670	0.8950	0.0748	0.62	0.5555	1.9386	0.2864
0.12	0.0753	0.9166	0.0823	0.63	0.5651	1.9592	0.2884
0.13	0.0839	0.9382	0.0895	0.64	0.5748	1.9800	0.2902
0.14	0.0925	0.9597	0.0964	0.65	0.5843	2.0009	0.2920
0.15	0.1012	0.9811	0.1031	0.66	0.5938	2.0219	0.2937
0.16	0.1100	1.0024	0.1097	0.67	0.6033	2.0431	0.2953
0.17	0.1188	1.0236	0.1161	0.68	0.6126	2.0645	0.2967
0.18	0.1277	1.0448	0.1222	0.69	0.6219	2.0860	0.2981
0.19	0.1367	1.0658	0.1282	0.70	0.6312	2.1077	0.2994
0.20	0.1457	1.0868	0.1341	0.71	0.6403	2.1297	0.3006
0.21	0.1549	1.1078	0.1398	0.72	0.6493	2.1518	0.3018
0.22	0.1640	1.1286	0.1454	0.73	0.6582	2.1742	0.3028
0.23	0.1733	1.1494	0.1508	0.74	0.6671	2.1969	0.3036
0.24	0.1825	1.1702	0.1560	0.75	0.6758	2.2198	0.3044
0.25	0.1919	1.1909	0.1611	0.76	0.6844	2.2431	0.3050
0.26	0.2013	1.2115	0.1662	0.77	0.6929	2.2666	0.3055
0.27	0.2107	1.2321	0.1710	0.78	0.7012	2.2906	0.3060
0.28	0.2202	1.2526	0.1758	0.79	0.7094	2.3149	0.3064
0.29	0.2297	1.2731	0.1804	0.80	0.7175	2.3397	0.3067
0.30	0.2393	1.2935	0.1850	0.81	0.7254	2.3650	0.3067
0.31	0.2489	1.3139	0.1895	0.82	0.7332	2.3907	0.3066
0.32	0.2586	1.3342	0.1938	0.83	0.7408	2.4170	0.3064
0.33	0.2683	1.3546	0.1981	0.84	0.7482	2.4440	0.3061
0.34	0.2780	1.3748	0.2023	0.85	0.7554	2.4716	0.3056
0.35	0.2878	1.3951	0.2063	0.86	0.7625	2.5000	0.3050
0.36	0.2975	1.4153	0.2103	0.87	0.7693	2.5292	0.3042
0.37	0.3074	1.4355	0.2142	0.88	0.7759	2.5595	0.3032
0.38	0.3172	1.4556	0.2181	0.89	0.7823	2.5909	0.3020
0.39	0.3271	1.4758	0.2217	0.90	0.7884	2.6235	0.3005
0.40	0.3370	1.4959	0.2252	0.91	0.7943	2.6576	0.2988
0.41	0.3469	1.5160	0.2287	0.92	0.7999	2.6935	0.2969
0.42	0.3568	1.5360	0.2322	0.93	0.8052	2.7315	0.2947
0.43	0.3667	1.5561	0.2356	0.94	0.8101	2.7721	0.2922
0.44	0.3767	1.5761	0.2390	0.95	0.8146	2.8160	0.2893
0.45	0.3867	1.5962	0.2422	0.96	0.8188	2.8643	0.2858
0.46	0.3966	1.6162	0.2454	0.97	0.8224	2.9188	0.2816
0.47	0.4066	1.6362	0.2484	0.98	0.8256	2.9832	0.2766
0.48	0.4166	1.6562	0.2514	0.99	0.8280	3.0667	0.2696
0.49	0.4266	1.6762	0.2544	1.00	0.8293	3.2670	0.2538
0.50	0.4366	1.6962	0.2574				





values. A further advantageous feature is the four places of decimals.

Diagrams are attached to show the general course of variation of the values with change of depth. These may be used direct for reading to two decimal places.

New Tile and Concrete Floor

A new flat-ceiling, reinforced-concrete floor in which a large and novel shaped hollow tile acts as a void filler is being put on the market by the Richard F. Barry Co., 53 Oliver St., Boston, Mass. The accompanying drawings show an isometric view of one of the tile and a section through the completed floor before the floor covering has been placed. The advantages claimed for

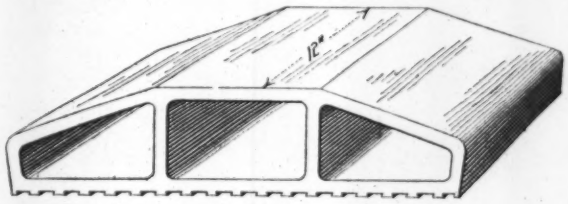


FIG. 1. ISOMETRIC OF TILE

the system are the ease in erection, due to the possibility of supporting the tile on plates under each beam, and the strength gained by the shape of the T-beam formed between the tile.

These T-beams are reinforced with tensile and shear steel in accordance with accepted design. The floor shown in the drawing is designed to support a 128 lb. per sq.ft. live-load over a 16-ft. span, assuming no continuity over the columns.

The tile are 36 in. long, 12 in. wide and 8 in. deep. They are being made at Toronto, Ohio, of fireclay.

Earth-Moving with Electric Dragline Excavators

An exceptionally high efficiency record of 1¼-cu.yd. electric dragline excavators is reported by F. T. Crowe, construction engineer of the U. S. Reclamation Service, in the June issue of the *Reclamation Record*. The excavators are of the same type as those employed on several of the reclamation projects (see ENGINEERING NEWS, Oct. 29, 1914, for description), and this record was made on drainage work on the Boise (Idaho) project in the month of March.

Mr. Crowe reports:

We are just completing the construction of approximately 50 mi. of open drains, involving the excavation of approximately 2,000,000 cu.yd. of earth. We have had an exceptional opportunity to organize one of the most efficient crews that I have ever seen on this class of work. Their March record, I believe, is a "world beater" for this size of machine. I would like to see their names in print, as they are certainly a credit to the service.

RECORD ON 1¼-CU.YD. ELECTRIC DRAGLINE EXCAVATORS, BOISE PROJECT, MARCH, 1915

Operator	Amount Excavated Linear Feet	Amount Excavated Cubic Yards	Average Number of Cubic Yards Excavated Per Hour	Average Number of Cubic Yards Excavated Per Shift
No. 1 Dredge, Solomon Slough Drain				
Wirth	4,110	27,621	158.1	987.0
Higley, F.	4,680	30,947	155.7	998.0
Lilburn, A. J.	4,520	30,065	152.3	1,002.0
Total and average	11,310	88,633	155.3	996.0
Highest run in one shift: Wirth, 1436 cu.yd.				
No. 2 Dredge, Dixie Drain and Drain from Upper Embankment				
Bates, S. H.	3,408	19,997	129.6	831.5
Stone, O.	4,076	24,786	127.7	953.5
O'Bryan, R.	3,688	22,781	124.0	813.5
Total and average	11,172	67,564	136.8	866.0
Highest run in one shift: Stone, 1,287 cu.yd.				
No. 3 Dredge, Laht and Griffith Drain				
Martin, W. H.	3,306	27,630	189.6	1,151.0
Jennrich	3,363	28,836	180.3	1,202.0
Gibson, C. A.	3,318	28,277	171.1	1,178.0
Total and average	9,987	84,743	180.3	1,176.0
Highest run in one shift: Martin, 1701 cu.yd.				

NOTES

Proportioning Costs of Highway Bridges Between Street Railways and Cities—The transformation of street cars within the last 25 yr. from light-weight horse cars weighing no more than heavy trucks and drays to large power vehicles frequently weighing 40 or 50 tons, and even 75 tons, has necessitated the strengthening of many existing highway bridges otherwise adequate, and has made it necessary to build new bridges of sufficient strength to carry these loads. Just how this additional expense should be apportioned between street railways and cities is a perplexing problem and forms the subject of a paper by Charles M. Spofford, Boston, Mass., which he presented on May 10 before the Western Society of Engineers at Chicago. The author's experience on this class of valuation work was gained entirely in Massachusetts, so that some of his conclusions, which follow, may not apply to other states:

(a) Additional width to provide for street cars is ordinarily necessary only in the case of bridges with narrow roadways, providing for no more than two lines of traffic.

(b) The extra expense involved in strengthening heavy city bridges of permanent type to provide for 50-ton trolley cars would not ordinarily be greater than 10% of the total cost, and may be as low as 6%. This percentage will be greater for light country highway bridges without paved floors, but if such bridges are designed for heavy motor-truck traffic, as they should be, the additional expense will not be excessive.

(c) To apportion the cost equitably, and with credit to the engineering profession, the engineers on the two sides should try to agree upon the additional cost of provisions for street cars before the case is presented to an apportionment commission. This can ordinarily be done if both sides are reasonable.

(d) It is doubtful if the railway company should ordinarily be charged for additional convenience due to the reconstructed bridge. This, however, is a matter the settlement of which hardly comes within the province of the engineer.

Rapid Concrete Mixing in the construction of Dry Dock No. 1 at Balboa, C. Z., is reported in a recent issue of the

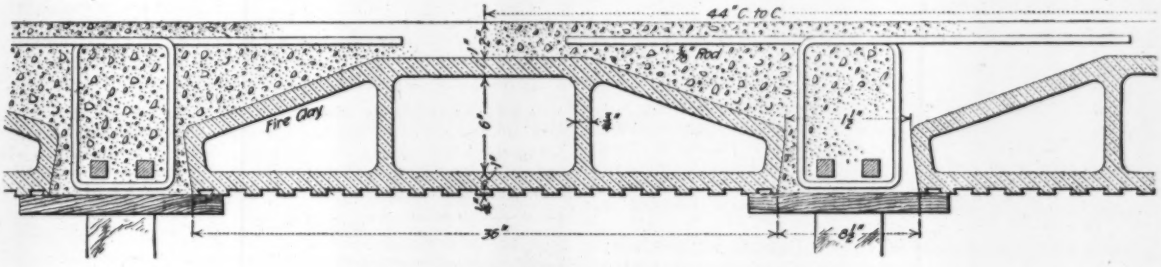
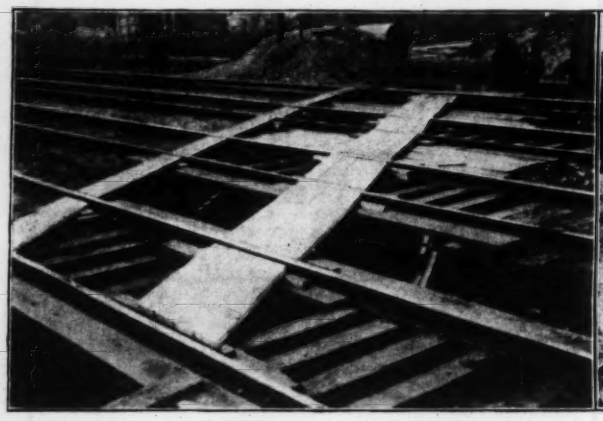


FIG. 2. SECTION THROUGH THE BARRY FLOOR

"Canal Record." During an 8-hr. period, in which a foreman (one-half time), a subforeman and 29 men were engaged, 321.94 cu.yd. (494 batches) of concrete was mixed in a nominal half-yard batch mixer. During the 8-hr. period 30 min. were lost while the chutes for the mixed concrete were being washed and 75 min. were lost in waiting for forms. The actual working time was, accordingly, 6 hr. and 15 min. The half-yard mixer, therefore, made a record of mixing 321.94 cu.yd. of concrete in 6 hr. and 15 min. at a labor cost of $34.87, or $0.108 per cu.yd. This means that a batch of concrete was turned out every 46 sec. The yardage of gravel used is about the same as the yardage of concrete mixed. The 18 men trundling the wheelbarrows handled in the 6 hr. and 15 min. about 321 cu.yd. of gravel, an average of 17.8 yd. per man. This is equivalent to 2.85 cu.yd., or about 76.9 cu.ft. per hr. As the gravel as handled at the dry dock weighs about 115 lb. to the cu.ft. each man was handling about 8840 lb., or 4.44 tons, per hour of working time, which is an average of over 147 lb. per min.



FIGS. 1 AND 2. PLACING A 60-IN. RIVETED STEEL WATER MAIN UNDER FOUR-TRACK RAILWAY

The Status of City Survey Monuments—A correspondent has raised the query as to the legal strength of city highway monuments, or bounds, in establishing property lines. The excellent practice of many cities in clearly defining the highway limits by stone or concrete monuments is a great help to property owners in locating and describing their lots; but the question naturally arises, what is the status of these bounds where their use conflicts with older and longer recognized corners? Doubtless many of our readers who practice city surveying are familiar with such controversies, and we would be glad to hear from them

Highway-Bridge Details—Some little points whose observance adds to the life of the iron railings of concrete bridges are shown in the accompanying illustrations. Fig. 1 shows the ordinary type of cast-iron post-and-pipe railing. By filling the post and pipe with concrete or mortar, the rapid disintegration due to interior rusting is avoided. Fig. 2 shows an intermediate post with an ordinary post cap for holding the pipe rail. By placing a special cast-iron saddle between this and the iron pipe rail, the painting and preservation of the rail are greatly aided. Fig. 3 shows a brass sleeve to fit around the base of the post at the place it joins the concrete. This prevents rusting at a point where experience has proved many railing posts fail. The last-mentioned device is the suggestion of C. B. Albree; the others, of Willis Whited, of the Pennsylvania State Highway Department.

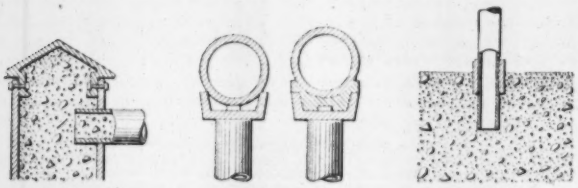
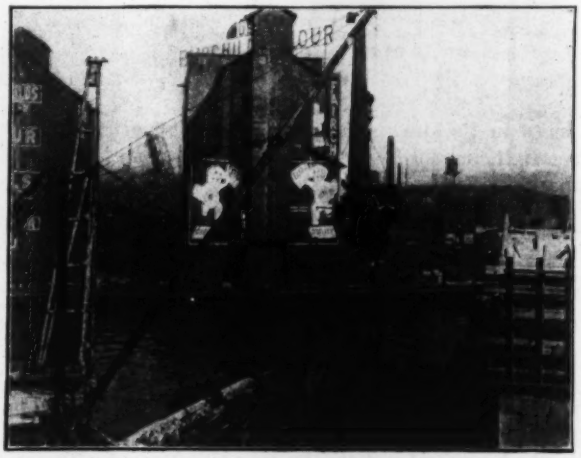


FIG. 1 FIG. 2 FIG. 3

BRIDGE RAIL DETAILS, PENNSYLVANIA STATE HIGHWAY DEPARTMENT

Putting a 60-In. Water Main under Four Tracks of the Boston & Albany R.R. was a part of the work of installing a new main connection to the Metropolitan Water District, west of Boston, Mass. The main crosses the tracks at an angle of about 30 deg. This is the main line of the B. & A. R.R. and the New York, New Haven & Hartford R.R., west and north respectively, and fast trains pass every few minutes. The work was done under the supervision of the B. & A. R.R. engineering and track departments, and a watchman was kept on the job day and night. The excavation was started from the near side (Figs. 1 and 2), and sheeting placed as fast as the trench progressed. Excavation under the tracks was started by digging pits just back of where the sheeting was to be placed and laying down on either side two 12x12-in. timbers, 12 in. below the bottoms of the ties, which were temporarily blocked up. On these 12x12's were placed three 12-in. I-beams under and parallel to each rail. Excavation work then proceeded under the tracks. The sheeting was of 2-in. planks on end, and three 6x6-in. timbers were used for longitudinal waling. The 60-in. riveted-steel pipe was unloaded at the near end (Figs. 1 and 2) and drawn through the trench in 10- or 12-ft. sections by a windlass on the far side; it was lined in by the use of two handjacks and braces placed against the upper and lower edges of the pipe, blocked up, and riveted in place by hand hammers.

An Unusual Filling Method—Back-filling at the west river pier of the Detroit-Superior viaduct in Cleveland, Ohio, is being done by the wagon-dumping method illustrated in the accompanying view. The horses are unhitched and the loaded wagon is lifted bodily, swung out over the fill by the derrick, and dumped. The empty wagon is returned to land, the horses are rehitched and the wagon returns for another load.



UNLOADING WAGONS BY DERRICK

Hydraulic Cement has been made for centuries in India and Burma by mixing pure slaked lime and "soorkhee," a finely powdered red brick. A mixture of one-sixth underburnt "soorkhee," one-sixth well-burnt "soorkhee," one-third slaked lime and one-third sand makes a dense, waterproof mortar.

Editorials

An Object Lesson in Engineers' Registration Laws

We especially commend to those of our readers who may have been disposed to favor legislation in the several states for the examination and registration of professional engineers the paper published elsewhere in this issue describing the situation in Canada, where the land surveyors of one province are forbidden by law to do work across the boundary in a neighboring province without undergoing an examination and obtaining a license.

No doubt the answer will be made that under proper state registration laws an engineer who had been regularly examined and licensed in one state would by a reciprocity arrangement be given the right to practice in other states by filing a certified copy of his registration certificate or by some similar formality. Anyone who has paid any attention to the vagaries of legislation, however, must realize that such reciprocity arrangements, admirable as they may seem to be, are very likely to fail of adoption. In any state that passes a law compelling the registration and licensing of engineers there is very likely to arise a strong movement to shut out the competition of engineers resident in other states. An illustration of this is a bill for the registration and licensing of engineers which was introduced in a Western state legislature last year and which contained the provision that an engineer from another state, in order to obtain registration and license, must pay a fee of $500.

One calls to mind the ancient Arab proverb, "The time to keep the camel out of the tent is when he first sticks his nose underneath the tent's flap."

A Bridge of Fact and One of Fiction

If engineers are apt to be contemptuous of that romance that writers of fiction are continually finding in engineering work, it is due not so much to the fact that the daily labor of design and the sordid details of construction rub off some of the glamour of high adventure as to the appalling ignorance that such writers display of engineering facts and methods. Disrespect for the dry meat of what is said is so great as to cancel all respect for the way it is said or the sugar-coated details that surround it. There is no need to remind engineers that Rudyard Kipling is a shining exception to this general charge; he can indeed convince the most practical of engineers of the reality of the romance of the profession quite as much by the magic of his words as by the accuracy of his observation.

If emphasis were needed of this power of expression an admirable opportunity is afforded by a comparison of the clear-cut, technical description of the Hardinge Bridge across the Ganges printed on another page of this issue and Kipling's description of the Kashi Bridge, also across the Ganges, in that greatest of engineering romances, "The Bridge Builders." In making this comparison we do no injustice to the author of our article. We only call attention to the variance between plain facts as they must be expressed in technical literature and fiction, where the fiction is in the hands of a master artist.

The problem of crossing the Ganges is the same today as it was 20 years ago, and, making allowances for developments in bridge design, the Kashi Bridge is the Hardinge Bridge—the same multiplied spans, the same deep piers in the shifting sand, the same sudden and fierce floods, the same Bell's bunds, and, above all, the same horde of native laborers, a mass of individual inefficients contributing to an efficient crowd.

Let the reader who is interested in the Hardinge Bridge turn once again to "The Bridge Builders" if he would visualize the construction there; let him read again what Findlayson, C.E., saw from his trolley on the river bank:

> The raw earth-ends were crawling and alive with hundreds of tiny asses climbing out of the yawning borrow-pit below with sackfuls of stuff; and the hot afternoon air was filled with the noise of hooves, the rattle of the drivers' sticks and the swish and rolldown of the dirt. The river was very low, and on the dazzling white sand between the three center piers stood squat cribs of railway sleepers filled within and daubed without with mud to support the last of the girders as those were riveted up. In the little deep-water left by the drought an overhead crane traveled to and fro along its spile pier, jerking sections of iron into place, snorting and backing and grunting as an elephant grunts in a timber yard. Riveters by the hundred swarmed about the lattice side-work and the iron roof of the railway line, hung from invisible staging under the bellies of the girders, clustered round the throats of the piers and rode on the overhang of the footpath stanchions; their firepots and the spurts of flame that answered each hammer stroke showing no more than pale yellow in the sun's glare. East and west and north and south the construction trains rattled and shrieked up and down the embankment, the piled trucks of brown and white stone banging behind them till the sideboards were unpinned, and with a roar and grumble a few thousand tons more material were flung out to hold the river in place.

The Norfolk & Western Electrification

The equipment of the Elkhorn grade on the Norfolk & Western Ry. for electric traction, as described elsewhere in this issue, is seen, even from the most casual inspection, to possess features of unusual novelty and interest.

For instance, the locomotives run under a single distributing contact wire; but the current is converted, by a small and simple auxiliary machine, from single-phase to three-phase for induction-type driving motors, the desirable characteristics of which for certain traction services are well known. Here is the first important commercial use of direct one- to three-phase conversion.

The use of this kind of motor makes easy the employment of regenerative braking, with all its obvious saving in the maintenance of mechanical equipment. Here, on steep mountain grades and with extremely heavy trains, is the most important use of regenerative railway braking yet attempted anywhere in the world. These two points alone mark this installation as worthy of study,

now and for some time to come while operating data are being developed.

If any of our readers have been misled by the comparative quiet existing in the camps of direct- and alternating-current traction exponents, and have thought that these systems have settled down to fixed developments and standardization, the Norfolk & Western work will disabuse their minds. Local conditions have profoundly influenced both the general features of design and the details. For instance, as will be shown in a later issue of ENGINEERING NEWS, the complete absence of long tangents on the Elkhorn grade has made possible the use of light steel cross-bridges to support the overhead wires, whereas on other lines a construction would be demanded which interfered less with the enginemen's view of signals. Such changed local conditions explain the differences seen between the Elkhorn bridges and the cross catenary supports designed by the same engineers for the Pennsylvania R.R. at Philadelphia.

The Commission Plan for Control of Public Works

A committee of engineers representing various engineering societies has recommended to the New York Constitutional Convention that the revised Constitution of the state should provide for the organization of a Department of Engineering and Public Works. This department would take over all the work now devolving upon the State Engineer, upon the State Superintendent of Public Works and upon the Department of Highways. In addition, it would have control of the erection and maintenance of all state buildings and the work now done by the Department of Conservation, which includes the control of the state's great forest reserve, of all works for the preservation of fish and game and of any work that may be undertaken by the state for the development of its water powers.

To this proposition to consolidate all the constructive work undertaken by the state in one department there appears to be no serious opposition. In fact other organizations have come before the convention and urged a similar consolidation. The committee of engineers, however, recommends that the proposed department should be in charge of three commissioners, whereas others urge that the department should be in charge of one man.

It may seem to those who have not given the matter attention that the difference is an unimportant one. The committee of engineers, however, believes that it is a difference of exceedingly great importance and that upon a wise choice in this matter rests the future success of public works administration in New York. Nor need we confine it to New York, for the question of proper organization for the efficient conduct of public works interests engineers in every state of the Union.

There is undoubtedly a strong and growing body of public opinion which favors the transfer of more and more work to public control in place of private enterprise. But if this policy is to be made a success and public works are to be carried on for the benefit of the people as a whole and not made a heavy burden to the taxpayer, then they must be conducted with honesty and efficiency. They can be so conducted only if a proper organization is provided.

Engineers are particularly interested in this question because a very large proportion of the engineering profession is engaged in public work, for states or cities or the nation. These engineers desire that the conditions under which they work shall be such as will enable them to work efficiently and honestly. It is a fact that a large proportion of the engineers now engaged on public works have to serve under conditions which encourage bad service and make good service difficult.

It is therefore a matter of great moment to the engineering profession that this question before the New York Constitutional Convention shall be decided right. Engineers know better than any other class in the community the great cost of the revolutionary changes which have occurred in the public works system of New York and of other states, to say nothing of the nation. The protesting taxpayers of New York appear to be finding out for themselves this year that something is wrong with the system they have followed in the past.

The organization of the Department of Engineering and Public Works proposed by the Committee of Engineers is briefly described as follows:

> A Department of Engineering and Public Works should be created to be headed by three commissioners appointed by the governor, each to have a 12-year term of office so arranged that a vacancy will be created every four years immediately after the inauguration of a new governor.
>
> This department should have charge of public lands and boundary surveys; of buildings, parks, highways, canals and other public works, including design, construction, maintenance and operation; and of the conservation and development of state resources.
>
> This department should be divided into suitable bureaus. Each bureau charged with responsibility for engineering work should be headed by a Chief Engineer selected by the commissioners with sole regard to his peculiar fitness for the duties of the bureau.

Now, what are the advantages of having three men instead of one at the head? In the first place, *a continuing organization* is secured. Only one commissioner goes out of office at a time, and the work of the commission goes on without interruption while the new commissioner is familiarizing himself with the department's work.

Under the one-man-control system, on the other hand, the head of the department is changed every time a new governor is elected; and a change in the head of the department generally means a change a long way down the line. These changes are made, it is almost needless to say, not for the purpose of increasing the efficiency of the work, but to give places to political workers.

That is the way the thing has been done in New York State in the past in the departments where one-man control has prevailed. Such wholesale changes have not been made, however, in those public works of New York which are under control of commissions. There the engineering staff has remained continuously, although there has been gradual change in the personnel of the commissions over them.

Surely, this is a most important matter to the engineering profession. It is not alone that engineers are pleased to see men of their profession, who make good in their positions, continue steadily in their places, year after year, until the work they are in charge of is completed. The engineering profession desires to have work carried on in this way because only in such a way can engineering work be accomplished that will be a credit to the pro-

fession and that will encourage the public to make larger use of the talents of the engineer.

It needs only the slightest knowledge of human nature to realize that where work is carried on by a continuing organization and where those in charge of it feel secure in their positions, provided they demonstrate their ability, the general tendency will be to have every man from highest to lowest do his best. On the other hand, where the opposite condition prevails—where the men in responsible charge understand perfectly well that they are holding office as a political prize and that, no matter how well they perform their work, as soon as a change in the administration comes they will be fired to make room for somebody else—under those conditions it is merely the instinct of self-preservation that causes the man holding a position to try to make all he can out of it while it lasts. In short, this system of organization, despite any and all laws that may be passed, is a direct inducement to all sorts of corruption and graft.

Contrast with it the control of the department by a commission of three proposed by the Committee of Engineers in the paragraph quoted. Each member of the commission is appointed for a 12-year term and is made eligible for reappointment. The chief engineers of the various bureaus in a department so organized would doubtless be as permanent in their positions as are the engineers in charge of work under other state commissions in New York or in Massachusetts or in other states which have adopted this sensible plan for conducting public works.

Much more might be said as to the advantages of the continuing organization which may be secured through the commission plan of control as compared with the periodical turnover, which usually happens in an organization under one-man control; but there are other important reasons why commission control is to be preferred. The commission plan is far safer than the one-man control.

One reason why it is safer is because of the ever-present temptation to graft and corruption in public life. If one man has the sole responsibility for the conduct of a great department and he is answerable to no one but a governor busy with a hundred other matters, the public's protection against corruption is only one man's conscience, character and courage. With a board of three men in control, however, there must be a conspiracy of all three to deliberately sacrifice their principles for the sake of politics or pelf before anything seriously wrong can take place.

Any such position of great responsibility, moreover, carries with it dangers as well as rewards. Political and business influences can be concentrated at a state capitol to work most powerfully for the destruction of the man who is brave enough and conscientious enough to stand for the public interest against all comers. Suppose the head of the department decides that a certain asphalt specification is necessary to protect the public interest, and powerful financial and commercial interests who find the decision interferes with their business unite to declare that the head of the department making this decision has done so from corrupt motives. It is easy to start a scandal of that sort attacking the character of one man, and effective defense is very difficult, since the public has no means of judging on these technical matters. It is easy to see how by blackmail of that sort a perfectly honest man at the head of a department might be driven out of office.

The situation is entirely altered, however, when, instead of one man, a commission of three men of character and reputation share the responsibility. The three can defend one another against such unjust attacks. Moreover, the corrupt interests would fear to attack a commission of three, when they would not hesitate to blackmail one man at the head of a department.

There is another reason why it is far safer for the public to have a commission of three men instead of one man at the head of a great department such as is here proposed. The combined wisdom or judgment of three men is a better and safer guide than that of one man alone. This proposed department would have under its charge public works representing an investment of more than $300,000,000. It would have to decide broad questions of policy respecting their conduct. Upon it will rest the responsibility of formulating and originating plans for future development and recommending them to the governor and to the legislature. For these great tasks the combined wisdom of three men is surely better than the unsupported judgment of one man alone.

This is not a matter of theory, but of practical experience. Any man who has actually served on a commission, with men of character and ability as his associates, will testify that the plans made and the decisions reached as a result of the discussion and suggestion and argument were better than he would have produced had the sole responsibility rested on him.

And at this point it is well to emphasize the fact that it is the duty of a commission to deal with the broad questions of policy and it should not attempt to perform detail executive work. It is through misunderstanding of this matter, probably, that nine-tenths of the opposition to commission control of public work as compared with one-man control has arisen.

There has been a great deal of superficial talk during the past few years concerning the merits of one-man control and the inefficiency of commission management. Those who argue for this policy fail to understand that it is not the business of a commission to do executive work. Where executive work is to be carried on, one-man control is desirable. Where the broader questions of policy are to be determined, the old adage holds true: "In a multitude of counselors there is safety." Furthermore the study and decision of broad questions of policy should rest with men who are not encumbered with executive detail and routine and are able to consider such questions in their broadest aspects.

We deem it well to emphasize this matter. The proposition of the Committee of Engineers is not that the commission at the head of the Department of Engineering and Public Works should perform the detail work of administering and ordering everything in connection with the vast enterprises under its charge. The commission would carefully choose the chief engineers and heads of bureaus of the various branches of work under its control and would delegate to these men full responsibility for the details of operation.

Of course, the commission would keep a general oversight of everything under its charge and would see to it that the men to whom it delegated responsibility were equal

to their task. But this would not be its main work. Its main responsibility would be to deal with those questions of general policy which those in charge of executive work and detail routine administration are too busily occupied to study. It is, indeed, lack of attention to these broad questions of general policy that has been the cause of most of the failures in carrying on public work.

An excellent demonstration that commissions should undertake legislative work and not executive work is the experience with the commission plan of city government. Where the elected commissioners have attempted to divide the executive work of the various city departments among them, the result has often been disastrous. Success has been attained where the city commission has dealt with questions of general policy only, and has delegated the detail executive work to a city manager or to the heads of departments which it has appointed, giving them full responsibility for the conduct of their work.

In the present Constitution of New York the advantages of commission control have been recognized to a certain extent by creating boards made up of various elected or appointed state officials who serve on these boards ex officio. This is a common defect in governmental schemes which we earnestly hope may not be perpetuated in the new state Constitution.

Anyone should be able to understand that it is a bad thing to delegate responsibility to a man unless he is competent to carry that responsibility, and it makes little difference whether his incompetence is due to mental inability or to the fact that he has no time to spare for the duties assigned him. In either case the duties will either not be performed at all, or if the time available is inadequate for the work, then the duties will be inadequately performed.

It is usually the case when a mayor or governor or other busy elected official is made an ex-officio member of some board or commission that the responsibility in connection with it is not taken seriously, since he is already charged with duties sufficient to occupy all his time.

It has been proposed that the new Department of Engineering and Public Works in New York should be controlled by a board made up of the State Engineer with the Attorney General and the Comptroller as ex-officio members. To say that this is in no sense an equivalent for the proposition put forward by the Committee of Engineers is putting it very mildly. We do not have to go very far back in the history of New York public works to find a similar experiment tried. Governor Dix abolished the Highway Commission created during Governor Hughes' administration and in its place set up a board composed of the Chief Engineer of the Highway Department, with the State Engineer and one other elected official as ex-officio members. The result was, as might have been expected, that the ex-officio members assumed only nominal responsibility for anything that went on in the Highway Department.

But we need not confine our examples to New York. In states and cities all over the country the experiment has been tried of giving responsibility to ex-officio boards of elected officials, and it has always resulted in disappointment and failure. An excellent illustration is furnished in Florida, where a bill is now before the legislature to reorganize the work of draining the Everglades, which work has hitherto been in charge of a board of commissioners made up of various elected officials whose time was taken up with other duties, and who, it is charged, carried on the Everglades work with an eye to politics rather than with a view to securing efficient action. The bill now before the legislature takes the work out of the hands of this ex-officio body and places it in the hands of a commission of three men to be appointed by the governor who are to devote their entire time to the work.

This is an example of the failure of an ex-officio commission. On the other hand, examples of the successful conduct of public works carried out under an appointed commission can be quoted all over the United States. The State of Massachusetts, for example, has been more successful probably than any other state in the Union in carrying out great engineering works, such as the Metropolitan drainage system, the Metropolitan water-supply and the rapid-transit system of Boston and vicinity, in a manner that is a credit to the state and to the engineers who have been responsible for the work. Invariably this work in Massachusetts has been placed in charge of an appointed commission with members having direct responsibility and no other official duties.

In New York itself, the greatest public works ever undertaken by it and among the greatest in the world—the rapid-transit system of New York City and the new water-supply from the Catskills—have both been carried out under appointed commissions and in a manner which is a great contrast to the bungling mess which the State of New York has made in attempting to carry on its work with elected officials and one-man control with a nominal supervision by boards of ex-officio members.

It is probable that the work on the Panama Canal has been chiefly responsible in spreading abroad the idea that a commission control of public work is inefficient and that one-man control is the reverse. The answer to this is that the original commission appointed to build the canal failed because it made the mistake that has been explained above, of attempting itself to perform detail executive work. Moreover, when the organization was changed, the work was left in control of a commission, although executive responsibility was concentrated in the Chairman and Chief Engineer. The advocates of one-man control also will do well to reflect that governors will very seldom find a Goethals to place in a position of supreme authority.

There has been some criticism because the Committee of Engineers which has brought this matter before the Constitutional Convention represents national engineering societies as well as the local engineering societies in New York. The critics fail to recognize that this is a matter of importance to the profession the country over. If New York will take the lead by establishing a Department of Engineering and Public Works with a continuing organization, free from the liability to revolutionary change with each new governor, the opportunity will be open to establish the public work of the state upon an economical and efficient basis. It will be reasonable to hope that the plan may be followed in other states, and that in the Federal service itself the same principle may be applied, so that such important Government engineering bureaus as the United States Reclamation Service shall not be subject to reorganization with each change in the administration.

Letters to the Editor

The Recent Break in a 48-In. Water Main in New York City

Sir—The break in the 48-in. pipe line at 109th St. and Manhattan Ave., New York, as reported on p. 1148 of ENGINEERING NEWS of June 10, emphasizes the necessity for a more stable foundation for cast-iron pipe than is afforded by filled-in ground. Conditions disclosed by uncovering the five lines of pipe for the entire block between 109th and 110th St. make it a matter of wonderment that only one line broke, and that line at only one point.

When these pipe lines were originally laid it would have been a comparatively easy and inexpensive matter to go down to a reasonable depth with a concrete foundation at intervals of about 12 ft. This is being done now at a cost of from $20,000 to $25,000, many times the amount it would have cost in the first place.

An examination of the fracture of the pipe showed an exceptionally clean and strong quality of metal, and the direction of the crack, which was at a wide angle from a straight cross-section, indicated that the break was a long time under way; in other words, that it was a slow tearing apart of the metal, occasioned by the heavy weight and the gradual settling away of the foundation, leaving it unsupported.

Aside from this break the pipe was in perfect condition, showing practically no tuberculation and absolutely no sign of rust deterioration, the coating on the inside of the pipe being almost as clean as when taken from the dipping tank. Criticism of the pipe in cases of this kind is about as justifiable as criticism of a slate or other well-recognized fireproof roof which has collapsed after the building has been burned from beneath it.

P. C. MCWANE,
American Cast Iron Pipe Co.

New York City, June 12, 1915.

I-Beam and Channel Column Sections

Sir—In ENGINEERING NEWS, May 20, 1915, p. 971, the article entitled "Design of Steel Elevated Railways, New York Rapid-Transit System" and the remarks of the author with regard to the column sections on p. 977 call for some comment.

Referring particularly to the column section made of an I-beam and two channels with the flanges turned in, the author makes the statement that the I-beam is ineffective in resisting bending about the axis X-X. Of course, it is for this reason that the section is built as it is, with the two channels on the flanges of the I-beam. With the channels stiffening the I-beam flanges the section of the beam itself is quite capable of carrying considerable direct load in compression.

The author remarks that some difficulty developed in fabricating these columns, giving as his reason that the I-beams come from the rolls "invariably slightly warped." It is true that the beam sections after leaving the hot-beds of the mills are warped, but this condition is remedied at the mill by passing all of the beams through straightening rolls, after which it is impossible that they are warped to any great extent if this work is carefully done, and certainly not to such an extent as to cause trouble in building the column of sections of the type shown by the author.

The author's section "C," made of a beam and two channels, is rightly called more economical than section "D," made of a plate, four angles and two channels, and the shops with which the writer is connected have used this beam-and-two-channel section for years in preference to any other built-up column section, finding it the most economical in a large majority of cases and much easier to fabricate than any other built-up section.

The writer therefore feels that the criticism of this section and the advocacy of the use of a plate, four angles and two channels in its place tend to create the wrong impression, as from his experience there is no reason why the beam and two channels cannot be used in a majority of cases with entirely satisfactory results.

N. R. MCLURE,
Chief Engineer, The Phœnix Iron Co.

Phœnixville, Penn., June 4, 1915.

Repairing Pavements after Street Excavations

Sir—I read with great interest the very excellent letter in ENGINEERING NEWS, May 20, 1915, on repairs to brick streets; but I wish to add that, in my humble judgment, the writer has not mentioned by far the most important part of repairing paved streets of any kind of surface.

In opening pavements for ditches, the opening is seldom made much wider than the ditch itself. The concrete base is then replaced over the ditch, but has no bearing on the solid, undisturbed earth.

It would seem needless to state that the concrete should have a very considerable bearing on undisturbed earth if it were not that this bearing is seldom provided for. The writer has seen scores of such openings, but he has never seen one with an adequate provision for bearing. This is extreme but true. Of course, if the ditch is wide or the concrete base shallow, a little reinforcement should be placed in the bottom of the concrete so as to form a beam or slab.

What city engineer who permits this kind of pavement reconstruction would design a concrete beam with no end bearings?

E. R. HORTON, JR.,
Engineer, Southern Public Utilities Co.

Charlotte, N. C., May 28, 1915.

National Conference on City Planning

The seventh National Conference on City Planning, held at Detroit June 7 to 9, was well attended and was otherwise successful. As usual, a considerable number of engineers were present. A new element in the attendance was a number of real-estate men.

Three main subjects were discussed—(1) land subdivision, (2) the architectural side of city planning and (3) city-planning administration. By giving at least a whole session to each of these topics, by the careful choice of the leaders of discussion and by limiting voluntary speakers to five minutes the proceedings were given substance and life. Other associations please take notice!

Opening Addresses

The first of the opening addresses was by Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment, New York City, who spoke on "The Plan of the City." Such plans as most cities possess, Mr. Lewis stated, have been made by engineers or surveyors and do not sufficiently consider either the city as a whole or the city of the future. From an engineering viewpoint the city plan may be divided into four parts—the transportation, street and park systems and the location of public buildings.

In city planning, the engineer is the first man on the ground. Heretofore he has been more intent on the accuracy of his survey than on the many broader aspects of the subject; yet his every blunder affords an opportunity for someone later on to make a reputation for correcting the planning blunders of the engineer at an enormous cost.

R. Clipston Sturgis, of Boston, president of the American Institute of Architects, made a forceful address, in the course of which he summed up the city-planning needs of the day as being (1) common sense and (2) continuity of policy—the latter a thing seldom seen in this country.

Edward H. Bennett, of Chicago, Consultant to the City-Plan Commission of Detroit, reviewed the city plan of Detroit, both past and proposed.

Progress in city planning in the United States since the first City-Planning Conference was held in Washington in 1909 was reviewed by Flavel Shurtleff, secretary of the Conference. Numerically, the great advance of six years is partly shown by the increase in city-planning commissions from 1 to 91. A great gain has been the increased attention to city planning given by the regularly constituted city authorities.

Best Methods of Land Subdivision

A committee report on this subject was presented by E. P. Goodrich, Consulting Engineer to the Borough of Manhattan, New York City. The report and the lengthy discussion following it, which was carried over to a second session and then continued at a luncheon the next day, went minutely into such matters as size and arrangement of city blocks and lots. A feature of both the formal and informal discussions was the prominent part taken by real-estate men.

City Planning and Civic Design

The first attempts to arouse public interest in city planning in this country laid chief stress on its esthetic side and met with opposition rather than support. Later, city-planning propaganda was devoted almost wholly to its economic and social aspects. This has been a marked and, in fact, a carefully designed characteristic of the city-planning conferences. At Detroit the reins were loosened a bit and a session was given up to the architectural side of city planning. Several well-considered papers were presented by architects and will appear in the *Proceedings* of the Conference.

Constitution and Powers of a City-Planning Authority

In behalf of a committee on this subject, Robert H. Whitten, secretary of the city-planning committee of the Board of Estimate and Apportionment, New York City, submitted (1) a summary of replies to a questionnaire sent out for the committee and (2) a paper expressing his own ideas on the subject.

As to the desirability of having a single city-plan office in every city, 75 of 77 who replied said "yes." To the question should the city-planning authority have absolute or qualified veto or merely power to recommend, there was a plurality of opinion in favor of making the city council rather than the planning commission supreme. Of 68 who replied to the question how the planning authority should be composed, 2 said it should be vested in the city engineer, 2 in a committee of the city council, 2 in a commission of department heads, 26 in a commission of citizens, and 36 favored some combination of the foregoing plans.

Some of Mr. Whitten's own opinions may be summarized as follows: Ultimately there should be a city-plan office which would be an integral part of the city government. Except in small cities, art commissions and city-plan commissions should not be combined. The legislature should pass permissive rather than mandatory city-planning acts, and should stop short with general principles. The city council should be supreme to the extent that by a two-thirds vote it can override the city-planning commission. A state commission, with powers over various municipal affairs as well as city planning, like the Local Government Board of Great Britain, might be desirable.

A review of city-planning administration in Europe, with more particular reference to Germany, was presented by Frank B. Williams, of New York City. Historically, city-planning in Europe dates from 1865 in Sweden, 1872 in Italy, 1875 in Prussia and 1909 in England.

In thoroughness, Germany leads, yet it has not a single city-planning commission. Its control is exercised through a simple law giving cities power over street building lines and in a variety of other ways, all harmonized and strengthened by the state.

In the lengthy discussion which followed there seemed to be a general agreement that the city-planning authority should be vested in a committee composed of regular department heads and of citizens, but that the city council or other governing body should have final power in the matter, although not by a bare majority.

General Business

The affairs of the Conference will continue to be managed by an executive committee of 20 members, headed by F. L. Olmsted, who also serves as president. In addition

there is a large general committee, headed by George McAneny, of New York City. Flavel Shurtleff, 19 Congress St., Boston, Mass., is secretary of the Conference.

Reinforced-Concrete Sewer Viaduct

By E. Dow Gilman*

A sewer viaduct of unique interest was built in Duluth, Minn., during the past year. Duluth has a number of gullies and ravines, which, with the steep grades encountered, make the municipal engineering problems costly and difficult. The establishing of sewer grades is not one of the least difficult problems, and various means have been used to carry sewers across the ravines.

A year ago it became apparent that the 8-in. pipe in Fifth St., from 18th to 24th Ave. East, was inadequate to carry the sewage from the rapidly developing territory which it served, and plans were prepared for a 15-in. relief sewer. The old 8-in. pipe is carried across the ravine at 22d Ave. East in a wooden housing supported by a pile trestle. This has never been satisfactory, as it has leaked, required high maintenance costs, and cannot be considered a permanent structure. It was decided to use a reinforced-concrete viaduct to carry the 15-in. pipe across the ravine.

The original design for the viaduct was for a girder type of three spans, each about 36 ft. long. The girder

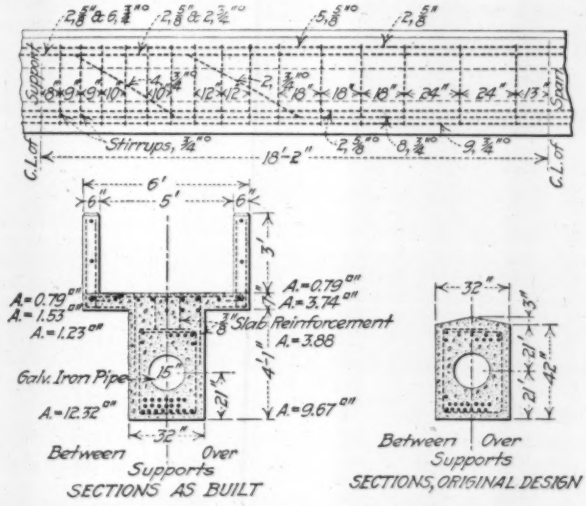


Fig. 1. Details of Sewer Crossing Ravine
(Original design and structure as built shown in the sections)

was designed to carry only the sewage and wind and snow loads. The top was sloped as shown by Fig. 1.

After the work was well under way, the piers completed, and all the steel delivered and bent to shape, the possibility of using the structure to serve a double purpose became apparent. The roadway is carried across the ravine by a bridge only 20 ft. wide, on which no footwalk is provided. Pedestrians were forced to step into the street, where in wet weather they were splashed with mud from passing vehicles. The line of the sewer, which was laid in the boulevard back of the curb, was nearly on the line of the sidewalk, and the grade was such that the top of the viaduct would come but slightly below the elevation of the walk. The location is in one of the best residence districts in Duluth, and the plain concrete viaduct would have been an unsightly addition. The idea of providing a walk over the top of the viaduct was suggested to the city council and was approved. The work proceeded in accordance with the modified design as shown in Fig. 1.

The steel already on hand had to be used. The stirrups bent to the original design were not high enough, and the shear above the stirrups was cared for by bending the reinforcing bars of the cantilever walk down to the center of the beam as shown by Fig. 1. Additional steel was required in the bottom and was provided by additional

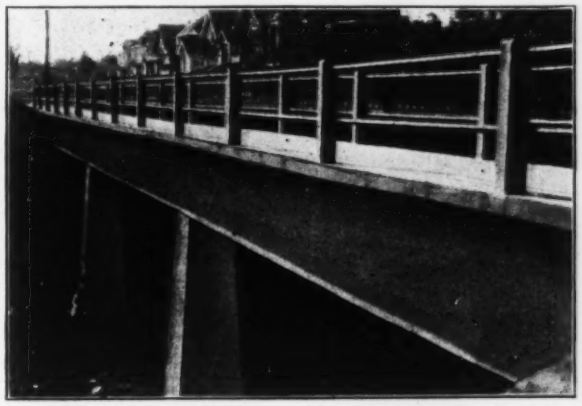


Fig. 2. View of Fifth St. Sewer Viaduct, Duluth

rods. It would have been preferable to provide the required area by a fewer number of larger units, but with the change in design this was impossible. In the endeavor to make the additional cost as low as possible concrete posts instead of iron posts were used. This did away with a large number of costly fittings and allowed stock lengths of pipe to be used. The result was not only economical, but was also more pleasing in appearance than the pipe posts would have been.

The design of the piers had been determined by their appearance of stability. Piers of just sufficient size to carry the load would have been unsightly, slender supports. Therefore, no changes were necessary in the design of the piers. No expansion joints were used, though two layers of tar paper were placed over each abutment to allow of some sliding at these points. As the sewer in this district is used for both storm and sanitary sewage, the relief sewer was to be used only during the rainy months, and it was unnecessary to provide against freezing. A 15-in. galvanized-iron pipe was used as a form through the viaduct.

The total cost of the structure, including all engineering expense, materials, labor and supervision, was $1792.82. The rails and posts cost $100.37, a unit cost of $0.43 per lin.ft. of railing. The total added cost due to the walk was $348.31, a unit cost of $0.51 per sq.ft. There was 86 cu.yd. of concrete used, making a total unit cost for the whole job of $20.86 per cu.yd. The cost was divided as follows: Material, $961.76; labor, $716.45; engineering and supervision, $114.61. These figures are slightly higher than they would be for duplicating the structure if originally designed as finally built.

*Assistant Engineer, Division of Public Works, Duluth, Minn.

Electric Traction on the Norfolk & Western Ry.

SYNOPSIS—The electrification of the "Elkhorn grade" in West Virginia shows radical departures from the features of earlier electric-traction work in the design of the locomotives and current-distribution system. The installation is of interest also as regards the traffic conditions and power supply. This article, the first of two from notes furnished by the road's consulting engineers, gives a brief review of the conditions of service and the reasons for abandoning steam locomotives, and describes the locomotives. The second article will deal with the overhead construction and power supply.

The electrified section of the Norfolk & Western Ry. is about 105 mi. west of Roanoke and extends from Bluefield to Vivian, about 30 mi. This is a double-track line

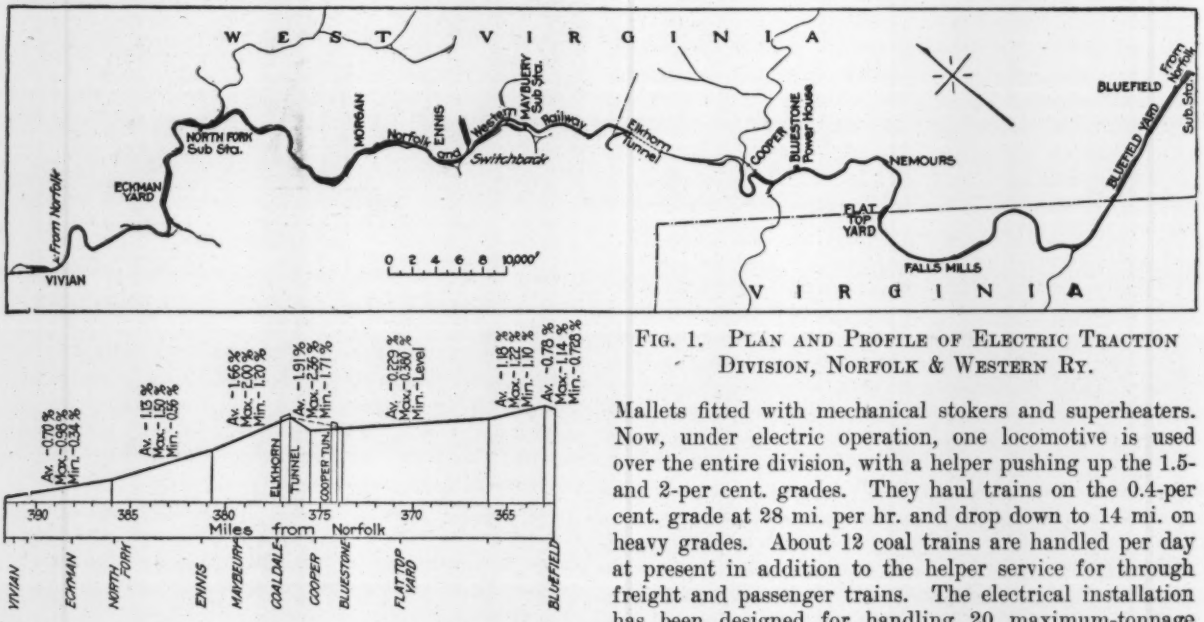


FIG. 1. PLAN AND PROFILE OF ELECTRIC TRACTION DIVISION, NORFOLK & WESTERN RY.

except for the stretch of single track through the Elkhorn tunnel. There is also a considerable length of passing sidings, coal branches and yard tracks. As shown in Fig. 1, the grades on the line are heavy, and fully 60 per cent. of the line is on curve, the maximum being about 12 deg.

This section is largely a local-switching and short-haul division between the coal mines and Bluefield. The coal traffic is sent east from Bluefield after classification. There is also over this section merchandise-freight and passenger traffic, which is still hauled by steam but with the electric locomotives as helpers on the grades.

The company's aim in electrification was, first, to increase the capacity of the line by reducing the time required to handle trains, and, second, to provide a more economical service over the heavy grades.

TRAFFIC CONDITIONS

The coal trains may be dispatched at uniform intervals throughout the day to give desirable loading conditions on the power system and full service with a moderate number of locomotives making several round trips each day. The electric locomotives have a running speed up grade of 14 mi. per hr., compared with about 7½ under steam operation, and there is a saving in time by the elimination of delays for taking on coal and water. The benefits of increased speed are particularly felt at the Elkhorn single-track tunnel. This is 3000 ft. long and on a 1½-per cent. grade. On account of ventilation it has been necessary, under steam operation, to reduce speed up grade to about 6 mi. per hr. This has required 7 min. to clear the block, whereas under electric traction the movement is made in 3 min.

The heavy coal trains on this line (3250 tons) have required three steam locomotives, a road engine and one helper being used over the entire section and a pusher up the 1.5- and 2-per cent. grades. These were heavy Mallets fitted with mechanical stokers and superheaters. Now, under electric operation, one locomotive is used over the entire division, with a helper pushing up the 1.5- and 2-per cent. grades. They haul trains on the 0.4-per cent. grade at 28 mi. per hr. and drop down to 14 mi. on heavy grades. About 12 coal trains are handled per day at present in addition to the helper service for through freight and passenger trains. The electrical installation has been designed for handling 20 maximum-tonnage trains a day east, with provision for additional traffic and extensions when needed.

POWER SUPPLY

Energy is generated, transmitted, and distributed over the line by single-phase 25-cycle and 11,000-volt current. At this potential it is taken by the locomotive from a catenary-supported trolley wire. The locomotives are unique, however, in that they transform the single-phase power to three-phase for use in induction motors. In this way the advantages of both high-voltage single-phase distribution and collection and three-phase motors are secured. One of the greatest benefits lies in the ease of regenerative braking of trains down grade by feeding energy back to the line.

REGENERATIVE BRAKING

This is the first important railway line in this country and the second in the world where electric braking has

been utilized to any great extent (the first being on the Giovi line in Italy). It has never before been applied to such tonnages as are found here. The heaviest trains coast down the mountain grades held by a single engine to a uniform speed of 15 mi. per hr., with the air-brakes in reserve for bringing the train to a standstill when required. There is a large reduction predicted in the wear of brakeshoes, tires, draft gear and general equipment, and there also will be some saving in power due to the return of energy to the line for other trains if there is a demand at the time. When there is no demand for the returned power it is absorbed by rheostats at the power house.

Locomotives

There are at present in use on the Elkhorn section twelve 270-ton electric locomotives, each consisting of two similar half units coupled together. The design provides for the severe requirements of this line without the special manipulation which has been needed with steam locomotives. (In handling the long and heavy trains on these mountain grades it is necessary to have part of the motor power at the rear end to avoid excessive strains on the draft rigging of the cars. With long trains there is difficulty in signaling from one locomotive to the other, so that often the rear locomotive is stalled for a minute or more in its effort to start the train before the head locomotive gets into full action. Also at times the head engine shuts off power and applies brakes while the rear engine keeps pushing.)

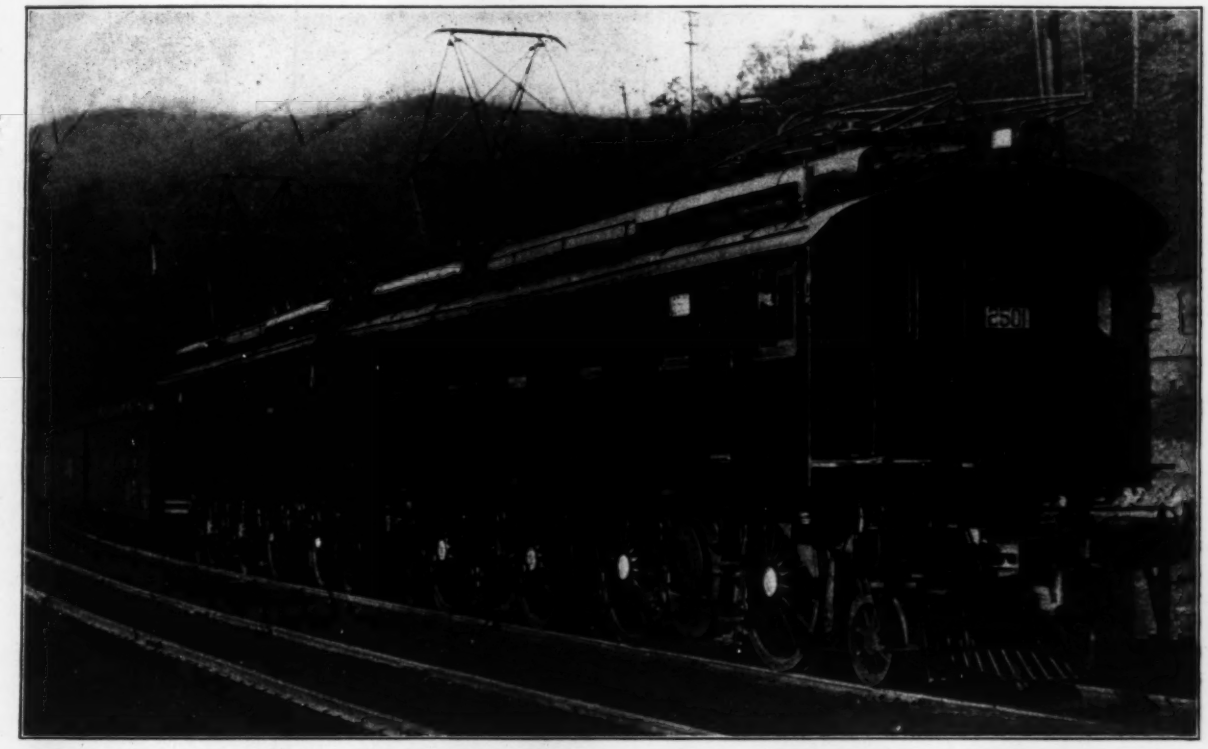


Fig. 2. The Norfolk & Western 270-Ton Electric Locomotive

Trucks and Cab

Each locomotive unit has two main trucks connected by a hinge; each truck has two driving axles in a rigid wheel base, and a radial two-wheel leading truck. The bumping and traction stresses are transmitted through twin draft rigging mounted on the main trucks and along the main frames. The cab is a box structure supported on the main truck by spring-cushioned friction plates—without weight on the center pins, which serve only to hold the cab in proper position. There are two end doors and a side door near each end on the engineman's side.

Motors

There are two three-phase wound-rotor induction motors on each truck. The shafts carry twin pinions meshing with a large gear on a jackshaft and therefore revolve in opposite directions. The jackshaft gear has a crank pin directly mounted on it with rods running to the drivers.

The locomotives have two running speeds—14 and 28 mi. per hr. For both speeds all motors are connected in parallel, but with an eight-pole arrangement of the motor field windings for the lower and a four-pole winding combination for the higher speed. Resistance is inserted in the secondary circuit of the motor in starting, a water rheostat being used because of the smooth gradations of tractive effort obtained and the ease of dissipating large amounts of heat by evaporation. The motors are cooled by air blast.

Phase Converter

Unit-switch control is used with a master controller in each operating compartment. The current comes from the 11,000-volt pantograph collector through an oil circuit breaker to the main transformers. To the low-tension side of the transformer is connected the phase converter, which operates constantly when the locomotive is in service. This machine is an idle induction motor

with a short-circuited or squirrel-cage secondary (rotor) and with two windings on the stator, one driving the rotor and the other furnishing current 90 deg. out of phase with the main supply.

As shown in Fig. 5, the driving primary circuit of the converter is connected across the secondary of the locomotive transformer, taking current at 725 volts. The displacement primary circuit is connected between the middle tap of the main-transformer secondary and one of the three-phase motor leads, giving a three-phase current by the equivalent of an ordinary two-phase-three-phase transformer connection. The converter passes only a small part of the current taken by the main motors, the rest coming directly from the main transformers. On the shaft with the converter is a single-phase series commutator motor for starting, a blower for cooling the motors and transformers and an air compressor, the latter being driven through a clutch.

Collectors

The pantograph collectors are raised and held in contact with the overhead wire by springs and are lowered by compressed air, locking when down. There are two sets of insulators in series supporting the frame. If it is found necessary in operation, the shoes will be fitted with end horns which will automatically fold in when the pantograph is lowered by the overhead wire through

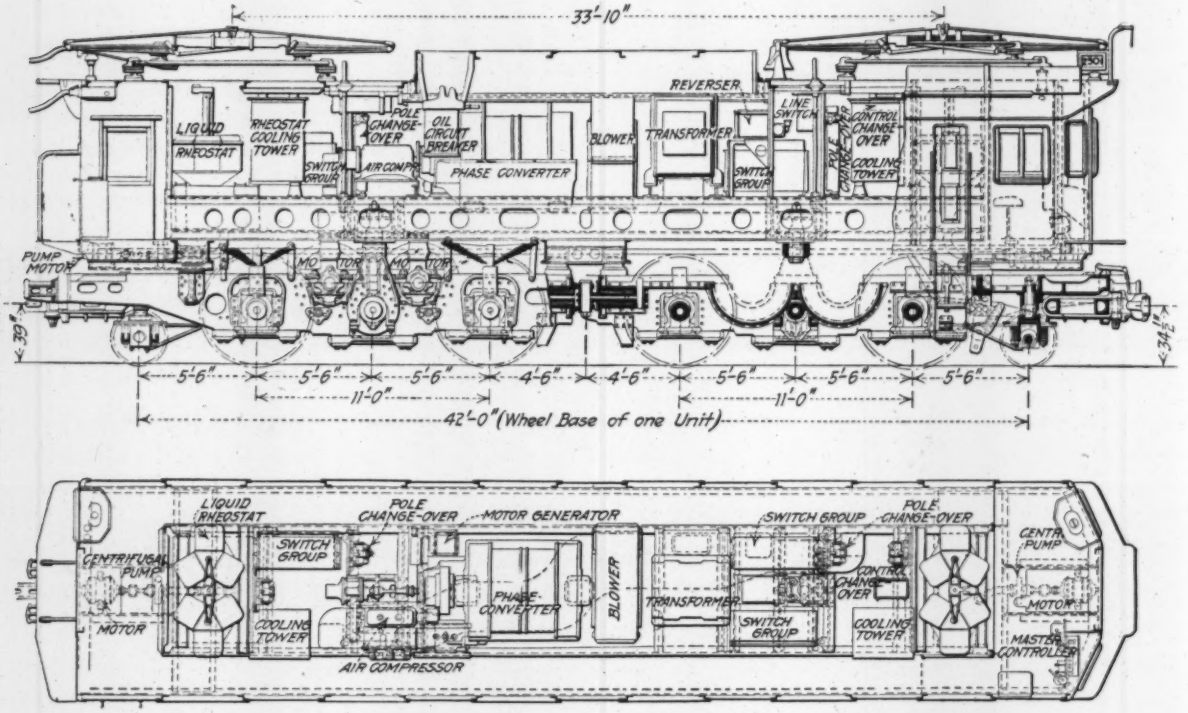


Fig. 3. Plan and Elevation of Single-Phase Three-Phase Locomotive

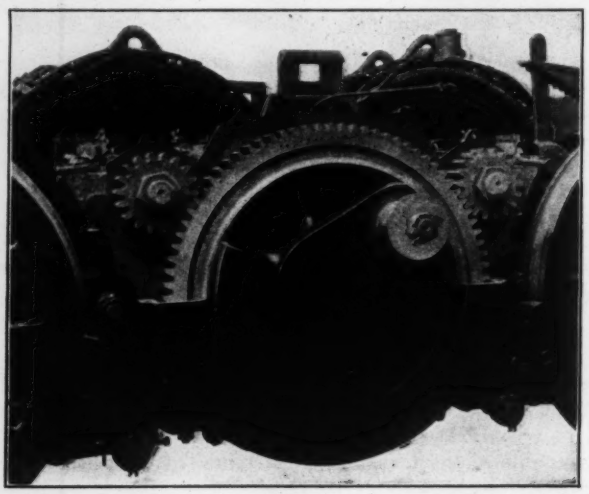


Fig. 4. Motors and Gears

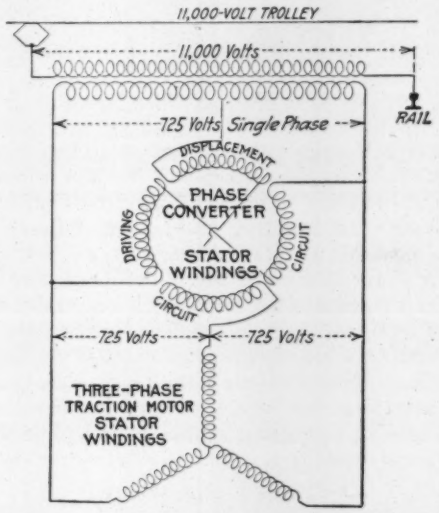


Fig. 5. Diagram of Single-Phase to Three-Phase Conversion

tunnels, accommodating themselves in this way to the restricted clearances.

Liquid Rheostats

There is a water rheostat for each motor; these are operated in pairs with one storage reservoir, cooling tower,

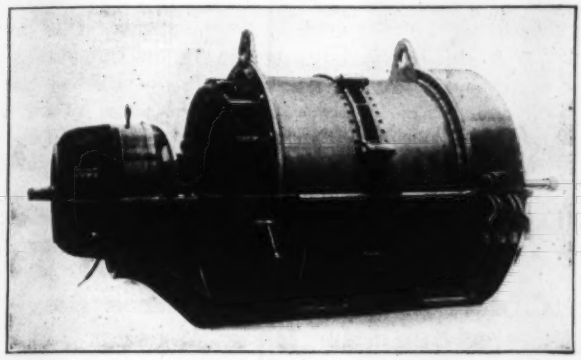


Fig. 6. Phase Converter

circulating pump and operating mechanism for each pair. The essential parts of each rheostat (see Fig. 7) are a cast-iron tank in which are mounted one set of metal plates connected to the motor and a second set of adjacent plates connected to the ground. The plates are not moved, but the water is raised or lowered. The higher the liquid rises on the plates, the lower the resistance becomes, the minimum resistance being placed in the motor circuit

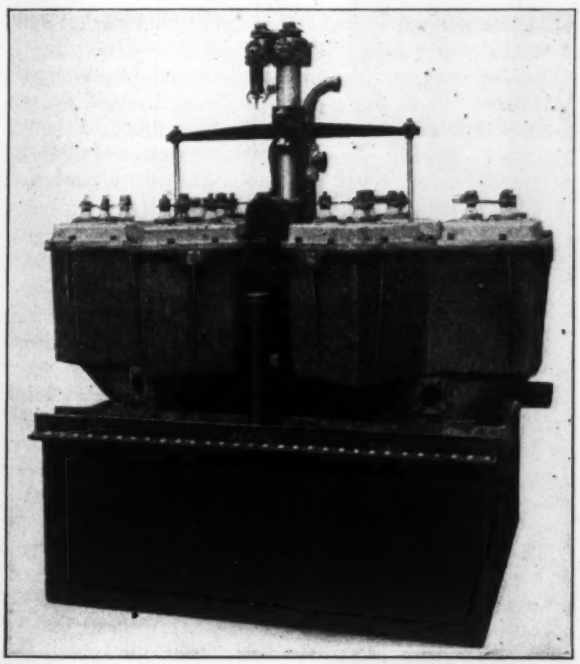


Fig. 7. Liquid Rheostat

when the plates are entirely submerged. The water is continuously circulated by a motor-driven centrifugal pump, and passes through the bottom of the tank over the top of a hollow plunger (weir) and back through the plunger to the storage reservoir. A portion of the water is bypassed through a cooling tower, where it flows over a series of trays and comes in contact with a stream of air from the main ventilating duct.

The more important dimensions and operating characteristics of the locomotives are shown in the table:

Length over double unit	105 ft. 8 in.
Driving wheel base	83 ft. 10 in.
Ridid wheel base	11 ft.
Truck wheel base	16 ft. 6 in.
Height, rail to locked pantograph	16 ft.
Height to top of cab	14 ft. 9 in.
Maximum width over all	11 ft. 6¼ in.
Width over cab body	10 ft. 3 in.
Diameter of driving wheels	62 in.
Diameter of pony wheels	30 in.
Weight on drivers	220 tons
Total weight	270 tons
Maximum guaranteed horsepower on 0.4 per cent. grade	6,700
Maximum guaranteed horsepower on 1 and 2 per cent. grades	5,000
Guaranteed accelerating tractive effort on 0.4 per cent. grade, pounds	90,000
Guaranteed accelerating tractive effort on 1 and 2 per cent. grades, pounds	13,300
Drawbar pull at uniform acceleration on 0.4 per cent. grade, pounds	79,400
Drawbar pull at uniform acceleration on 1 per cent. grade, pounds	114,000
Drawbar pull at uniform acceleration on 1.5 and 2 per cent. grades, pounds	91,800
Highest recorded drawbar pull, pounds	180,000

Engineers

The locomotives were built jointly by the Westinghouse Electric & Manufacturing Co. and the Baldwin Locomotive Works. The general layout and detail designs of the entire installation were the work of Gibbs & Hill, of New York City, the railway's consulting engineers. All construction, except the power house and some of its equipment and the inspection buildings, was carried out under the supervision of the consulting engineers by a specially organized railroad force.

Rapid Growth of Hawaiian Railway—The expansion of the railway system on the Island of Oahu is most gratifying to its backers, who were almost ruined during the first few years of operation. Twenty years ago there were 23½ mi. of track; today 127 mi. are maintained. According to A. P. Taylor, in "Commerce Reports," there are now 22 locomotives, 44 passenger cars and 520 freight cars. There are 36,000 ft. of wharfage with capacity for storing 20,000 tons of sugar. The gross earnings of the road 20 years ago were $120,000; now they are $1,300,000. Then 79,000 passengers were carried yearly, while in 1914 about 1,140,000 passengers were transported. This railway, which starts at Honolulu, taps five of the largest sugar plantations in the Hawaiian Islands, all the big pineapple plantations, several stock farms and rice and banana plantations, and skirts the shores of Pearl Harbor, where the United States Government is building a naval station and drydock. In addition to its commercial importance, the road gives access to some of the finest scenic features on the Island.

The Flow of the Colorado River is sufficient to irrigate the entire Colorado delta, according to a report made on May 24 by C. R. Rockwood, Chief Engineer of the Imperial Irrigation District. Twenty-three years ago, in 1893, Mr. Rockwood stated that the Colorado River furnished sufficient water to irrigate every acre on its lower drainage basin to which water could be applied. Data now available permit a much more comprehensive and complete report. Mr. Rockwood finds that the area which may be irrigated with the flow of the Colorado River at minimum stage varies from 4,672,000 acres in June to 829,000 acres in September. Below The Needles, Mr. Rockwood estimates that 1,700,000 acres may eventually require water. Long before this entire amount is brought under cultivation, however, it will be feasible to provide storage reservoirs on the upper tributaries of the Colorado for the impounding of flood waters; and with this done, the river can furnish an absolutely safe supply for the months of July, August, September and October, which are the only months in which the normal flow of the river might be inadequate. His final conclusions are that the river without storage can irrigate 1,200,000 acres, and with 2,000,000 acre-ft. of stored water every available acre below the Grand Cañon, including all lands in Mexico, could be irrigated. Even without storage and this entire area under irrigation, the worst that could happen in a year would be the loss of one or two cuttings of alfalfa on a part of the land.

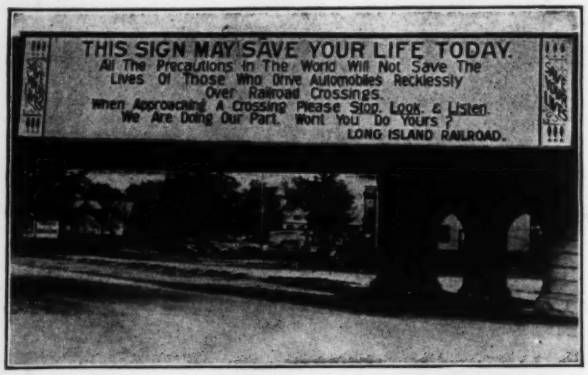
News of the Engineering World

The Illinois River 8-Ft. Waterway

The Illinois state legislature has passed the bill endorsed by Governor Dunne providing for a waterway of 8-ft. draft connecting the Chicago Drainage Canal at Joliet with the Illinois River at La Salle. The distance is 65 mi. The work will be partly river improvement and partly canal, and may be commenced this year and probably completed in two years. While this project has been advocated as part of a Lakes-and-Gulf waterway, it is said also that it will have considerable local traffic between Chicago and manufacturing establishments in the Illinois River valley. The bill provides for an Illinois River waterway commission composed of five members (one of whom is to be an engineer) and authorizes the expenditure of $5,000,000 for the waterway.

A Railway Campaign to Reduce Grade-Crossing Accidents

To protect automobilists at grade crossings on Long Island the Long Island R.R. has inaugurated a campaign of safety to impress automobile drivers with the vital necessity of prudence when approaching railroad tracks.


THIS SIGN MAY SAVE YOUR LIFE TODAY.
All The Precautions In The World Will Not Save The
Lives Of Those Who Drive Automobiles Recklessly
Over Railroad Crossings.
When Approaching A Crossing Please Stop, Look, & Listen.
We Are Doing Our Part. Wont You Do Yours?
LONG ISLAND RAILROAD.

NEW WARNING SIGN OF THE L. I. R.R.

The company's 400 mi. of trackage thread territory in which automobiles are probably more abundant than anywhere else in the world.

The company will spend $25,000 per month in urging automobilists to be careful. Advertisements known as "life-saving bulletins" are being inserted in newspapers and large warning signs have been posted conspicuously near the bridge and ferry entrances on Long Island and on the main thoroughfares. Some of these signs are 50 ft. long by 10 ft. high (see the accompanying view), while others will be 10 ft. square. Several will be electrically lighted at night.

J. A. McCrea, General Manager of the Long Island R.R., who was the originator of the new advertising campaign, recently stated that during the last ten years there has been a steady increase in the number of automobile accidents on Long Island grade crossings. This he attributes chiefly to the large increase in the number of automobiles. In the last ten years the railroad has eliminated 305 of its grade crossings at a cost of more than $15,000,000. In spite of this work there are still 631 grade crossings on the island. At the present time work is under way to eliminate 32 crossings. Of the crossings still existent 300 are protected by gates. The others are mostly on private roads or roads where the traffic is small.

Control of Utility Rates Restored in New Jersey

The New Jersey Court of Errors and Appeals on June 14 reversed its decision of Dec. 9, 1914, and confirmed the opinion of the Board of Public Utility Commissioners and the decision of the Supreme Court in the so-called Passaic 90c. gas case. As discussed in ENGINEERING NEWS, Jan. 21, 1915, p. 130, the decision which has now been overturned was notable for its rejection of the idea that franchise value was generally to be limited to that set up by cost and burden, for its adherence to the principle that franchises are property and hence have value, and for its recommendation that franchise value probably could be measured by the difference between market value of stocks plus floating debt and physical value plus development expense. Reargument had been sought by the commission and the municipalities involved on the grounds that the decision was against the intent of the legislature in passing the public-utilities law and that the recommended rule destroyed public control over rates.

244-Ft. Balanced-Lever or Direct-Lift Bridge for the Chicago River

The widening and improvement of 12th St., Chicago, necessitate the construction of a new drawbridge across the Chicago River. The design and size of the structure make it specially interesting. It will be of the direct-lift or balanced-lever lift type (see ENGINEERING NEWS, June 5, 1913, p. 1168), the span being raised in a vertical plane by means of levers rotating on trunnions carried by towers on the end piers or abutments.

The length of the lift span is 244 ft. As the bridge is on a skew, this gives a clear channel of 200 ft. The towers are square with the bridge. The deck is 90 ft. wide, with a roadway between trusses spaced 60 ft. c. to c., and two sidewalks outside of the trusses. The roadway will have a double-track street-car line. The weight of this span will be about 1000 tons. It will have a lift of about 100 ft., giving a clear headway of 120 ft. when raised. The towers will be 200 ft. high above the water, and the lifting levers will be 102 ft. long. The bridge will be operated by four pinions at the corners, engaging racks on the faces of the columns of the towers, the pinions being driven by four 65-hp. motors.

The bridge will be built for the city of Chicago, and the design has been approved by the Sanitary District and the Chicago Plan Commission. The city considered three types—the double-leaf bascule, the cable lift and the direct-lift or balanced-lever lift. The conditions to be met included non-interference with adjacent railway tracks and provision for shifting in the future to accommodate the possible straightening of the river. The first cost and maintenance cost were also considered favorable to the design adopted. This type of lift bridge is of very modern date. It was invented and patented in 1912 by Joseph P. Strauss, president and Chief Engineer of the Strauss Bascule Bridge Co., of Chicago. This company acts as consulting engineer for both the superstructure and the substructure of the 12th St. bridge. The approximate cost will be $400,000 for the former and $60,000 for the latter. The plans are being prepared, and contracts will be let in a few months.

Cleveland Opens Lake Pier

The new 9th St. Pier at Cleveland, Ohio, was opened for shipping on June 6 by the berthing of the Buffalo lake boat. This is the first large shipping pier in the city to be built out into the lake, all such traffic hitherto coming to piers in the narrow and tortuous Cuyahoga River. It will be used in the future for the Buffalo and Detroit lake steamers.

Celebration of the Fiftieth Anniversary of Worcester Polytechnic Institute

The fiftieth anniversary of the granting of a charter to the Worcester Polytechnic Institute, the first American technical school to establish a fully equipped manufacturing plant (the Washburn Shops) as an adjunct to a course in mechanical engineering, was celebrated at Worcester, Mass., June 8, 9 and 10. Delegates from nearly 100 colleges, universities and technical schools and from eight national engineering societies attended the exercises, which included a reception by Dr. Ira N. Hollis, president of the Institute; a public meeting in Mechanics' Hall, and the annual commencement exercises.

Addresses were made by Dr. A. Lawrence Lowell, president of Harvard University; John A. Brashear, president of the American Society of Mechanical Engineers; Governor Walsh of Massachusetts, and Dr. R. C. Maclaurin, president of the Massachusetts Institute of Technology. It had been expected that Maj.-Gen. George Washington Goethals, U. S. A., would be the chief guest of honor, but a summons to testify at a hearing of the United States District Court at Indianapolis prevented his attendance.

Another feature of the celebration was a banquet of the alumni, delegates and invited guests, at which speeches were made by Maj.-Gen. Leonard Wood, U. S. A.; Howard Elliott, president of the New York, New Haven & Hartford R.R.; Arthur D. Little, Consulting Engineer and Chemist, of Boston, Mass., and Senator John W. Weeks, of Massachusetts.

At a special meeting of the American Society of Mechanical Engineers held June 9 in the electrical engineering laboratories of the Institute, George I. Alden, of the board of trustees, formerly professor of mechanical engineering at the Institute, read a paper on "The Ideals of the Washburn Shops." Prof. W. W. Bird, head of the department of mechanical engineering and director of the Washburn Shops, also spoke.

Jitney Busses, owned by the Virginia Ry. & Power Co., are in operation in Richmond, Va., in competition with the free-lance vehicles which threatened to impair the earnings of the traction company. Maximum routes of 2 mi. in length are covered. These are parallel with the car lines, but about two blocks off.

A Decrease in Number of Street-Railway Accidents is reported to be one result of the universal adoption of "near-side" stops in New York City. For the first four months of 1915 accidents of all kinds on surface-car lines numbered 8597, compared with 10,650 for 1914. The number of fatal accidents fell from 37 to 29.

A Joint Outfall Sewer for El Centro and Imperial Valley, California, and a sewerage system for El Centro are proposed. To get a gravity outfall, El Centro decided to build an outfall 4 mi. long to Imperial, and the two cities agreed to continue this sewer by a joint outfall to the New River, 3 mi. farther on. El Centro has voted $250,000 of bonds and Imperial has voted $69,000 of bonds for the work.

Foreign Commerce Statistics for the ten months ended Apr. 30 show a reduction in the value of United States imports of about $200,000,000 and an increase in the value of exports of about $180,000,000. The increase in exports is due almost wholly to an enormous increase in the amount of foodstuffs sent abroad. Notwithstanding the large shipments of war materials, of which so much has been heard, the value of manufactured materials exported from the United States in the ten months is $40,000,000 less than in the ten months ended Apr. 30, 1914.

The Freight Steamer "Pennsylvanian" of the American Hawaiian Line has made the voyage from Philadelphia to San Francisco through the Panama Canal in 14 days, 17 hr. and 25 min. The "Pennsylvanian" is 408 ft. long and of 64-ft. beam. It is of 6649 gross tons and 4064 net tons register. The vessel covered the 5130 mi. from Philadelphia to San Francisco at an average speed of 14.551 knots. There was burned under the boilers 3977 bbl. of fuel oil, or 0.77 bbl. per mi.

Meetings of Engineers are to be held in San Francisco from Tuesday, Sept. 14, to Saturday, Sept. 25. The Road Congress, under the joint auspices of the American Highways Association and the American Road Builders Association, is to continue from Tuesday, Sept. 14, to Friday, Sept. 17, inclusive. On Sept. 16 and 17 are to be held conventions of the four national societies of Civil, Mechanical, Mining and Electrical Engineers, each society meeting separately. Saturday and Sunday, Sept. 18 and 19, are to be devoted to excursions to points of engineering interest in San Francisco and vicinity. The following week, from Sept. 20 to 25, is given up to the International Engineering Congress.

Low Prices for Brick Paving were bid on street contracts for which bids were opened in St. Louis on June 11. On two streets where specifications required a 5-in. concrete base and a cushion of dry cement mortar under the brick the prices bid were from $1.68 to $1.99 per sq.yd. on one street and from $1.82 to $2 per sq.yd. on the other. These prices did not include preparation of the subgrade. On five other contracts, where a cushion of limestone screenings was substituted for the cushion of dry cement mortar, prices ran from $1.67 to $1.87 per sq.yd. All these specifications included the use of wire-cut lug brick.

A Fire in the Hoosac Tunnel, in Massachusetts, starting at 8 p.m. on June 9, destroyed three freight cars and damaged others, blocking the tunnel. The first was caused by the breaking in two of a fast freight of the Boston & Maine R.R. bound for Boston. It appears that in the sudden stoppage of a portion of the train two cars were thrown against the 11,000-volt electric line suspended from the roof of the tunnel and caused the fire. The North Adams Fire Department, assisted by a force of railroad men, endeavored to check the fire, but was not successful. In the meantime trains on the Fitchburg division were detoured from Greenfield, Mass., to Springfield and thence to Pittsfield and North Adams over the Boston & Albany R.R.

A Proposed Central Parkway in St. Louis was defeated by a popular referendum vote in a recent special election. The St. Louis City Plan Commission proposed to condemn about 20 city blocks, from 12th St. to Grand Ave., through a dilapidated district, and to construct a new trafficway through the property to relieve congestion on Locust St., using the remainder of the area for park and recreation purposes. The/

total cost of the property was estimated at from $6,000,000 to $10,000,000. The plans were approved by progressive civic organizations of the city, but had to be submitted to a referendum vote on account of the clause in the new charter adopted by St. Louis last year providing for the initiative and referendum. A very active campaign was made by those favoring and opposing the parkway project, but a light vote was cast in the election, only about two-thirds of the registered voters appearing at the poles. The project was defeated by a majority of about 10,000. Since the election a committee has been organized for the better education of the public with regard to civic improvements, and it is probable that this proposition or a similar one will again be brought forward shortly.

A Street-Car Strike in Chicago, involving also all the elevated railways, went into effect Sunday night, June 13, and caused a complete stoppage of local transportation. About 14,000 men were said to have gone out. Negotiations between the men and the companies have been in progreess for some time, but the crisis came rather suddenly. Both sides proposed arbitration, but the unions made their acceptance of arbitration conditional upon certain concessions being made in advance by the companies. The latter declined to make these concessions, claiming that they would cause a great increase in expenses, and that the entire matter should be included in the arbitration. It is expected that "jitney" automobile service will be introduced and various makeshift arrangements made, while some of the large concerns are quartering employees in the downtown hotels. The companies decided to make no attempt to run the surface cars on the first day, but operated some trains on the elevated lines under police protection.

The Organization of a Civilian Engineer Corps as part of a national military reserve was discussed in "Engineering News," of June 3, p. 1086. The Western Society of Engineers has a special committee dealing with the subject. It appears that the United States War Department is not yet in position to propose a definite plan by which civilian engineers can be enrolled in a reserve. The General Staff of the army, under direction of the Secretary of War, is considering plans for such a reserve, and a letter has been drafted for distribution to members of engineering societies inquiring as to their views and their probable action in the matter. From this letter it appears that as engineer troops constitute about 5 per cent. of an army, the proposed regular army organization of 450,000 men would require an engineer force of 22,500, including 750 commissioned officers. About 150 of these officers would probably be furnished by the regular army and the organized milita, while the remaining 600 might come from among those engineers of experience in civil life who have proved themselves capable as leaders and managers of men. The committee of the Western Society of Engineers has urged members to join the engineer corps of the Illinois National Guard, which has an armory at Chicago. It has proposed also an inquiry as to the number of engineers who would take up a course of study in military engineering or would attend summer camps of construction.

PERSONALS

Mr. M. A. Mulligan was recently appointed Superintendent of the New York Division of the Lehigh Valley R.R.

Mr. T. L. Landers has been appointed Resident Engineer of the Intercolonial Ry., with headquarters at Truro, Nova Scotia.

Mr. Henry Ericsson, Building Commissioner of Chicago, Ill., has resigned and will resume his business as a builder and contractor.

Mr. John Ernest Lloyd, Assistant Division Engineer of the Baltimore & Ohio R.R., has been made Division Engineer, to succeed Mr. A. A. Jackson.

Mr. J. H. Nuelle, Chief Engineer of the New York, Ontario & Western Ry., at Middletown, N. Y., has received the additional appointment of Assistant General Superintendent.

Mr. Lee Highley, Assoc. M. Am. Soc. C. E., Chief Engineer of the Pacific & Idaho Northern Ry., has resigned his position and the office of chief engineer has been abolished.

Mr. Otto H. Tittmann, M. Am. Soc. C. E., formerly Chief of the United States Coast and Geodetic Survey, received the honorary degree of Doctor of Science from Stevens Institute of Technology on June 8.

Mr. Arthur C. Everham, M. Am. Soc. C. E., until recently Assistant Chief Engineer of the Kansas City Terminal R.R., has been appointed Chief Executive Officer of the Park Department of Kansas City, Mo.

Mr. M. R. Hull, who has been connected with the Engineering Department of the Anaconda Copper Mining Co. at Great Falls and Anaconda, Mont., for several years, has been appointed Superintendent of Construction at the Washoe Smelter at Anaconda.

Mr. Joseph Battles has been appointed District Sales Manager of the Terry Steam Turbine Co., of Hartford, Conn., covering the States of New Mexico, Colorado, Wyoming and the western part of Nebraska. Mr. Battles' headquarters are at 326 First National Bank Building, Denver, Colo.

Mr. Eugene O. Christiansen, Assoc. M. Am. Soc. C. E., has been appointed Engineer of the Special Tax Commission of Cambridge, Mass. Mr. Christiansen is a graduate of the Massachusetts Institute of Technology and was recently a student of the Harvard Graduate School of Business Administration.

Mr. Jacob B. McKennan, Jun. Am. Soc. M. E., formerly Manager of the Minnequa plant of the Colorado Fuel & Iron Co., has been made General Manager of the company, covering all of its holdings. Mr. F. E. Parks, formerly Assistant Manager, will succeed Mr. McKennan at Minnequa. Mr. McKennan's headquarters will be at the company's general offices in Pueblo, Colo.

Mr. Edwin Carlton Wood, Assoc. M. Am. Soc. C. E., has been appointed Engineer-in-Charge of paving of the City of Dallas, Tex. Mr. Wood was City Engineer of Ft. Worth from 1907 to 1909, and subseqrently went into the paving business there, in which he remained until his present appointment. He will be directly in charge of paving construction and maintenance.

Mr. Robert Ridgway, M. Am. Soc. C. E., on June 9 was awarded the degree of Master of Science in Civil Engineering by the New York University. Mr. Ridgway is Deputy Chief Engineer of the Public Service Commission for the First District of New York, under Mr. Alfred Craven, and is Engineer of Subway Construction. His portrait and a brief biography were published in "Engineering News," Oct. 8, 1914, p. 732.

Mr. William A. Smith, who for several years has been connected with the New York Central & Hudson River R.R. in charge of eliminating grade crossings in the vicinity of New York City, has been appointed Village Engineer of Tuckahoe and Town Engineer of Eastchester, N. Y. Mr. Smith has opened an office at Tuckahoe, N. Y., where, in addition to his other duties, he will conduct a consulting civil and municipal engineering business.

Mr. Henry Welles Durham, M. Am. Soc. C. E., recently Chief Engineer of Highways of the Borough of Manhattan, New York City, under President McAneny, and formerly Resident Engineer of Panama municipal improvements and of the Cape Cod Canal, announces his association with Mr. Percival Robert Moses, F. Am. Inst. E. E., Electrical and Mechanical Engineer, at 366 Fifth Ave., New York City, where he will engage in municipal engineering work.

Mr. Ray S. Huey, formerly Assistant General Superintendent of the Universal Portland Cement Co.'s plant at Buffington, Ind., has been appointed Superintendent of the company's plant at Duluth, Minn. Mr. Fred Robinson has been appointed Assistant Superintendent of that plant. Mr. C. O. Soderquist, formerly Superintendent of Mill No. 6 at the Buffington plant, has been appointed Assistant General Superintendent of that plant. Mr. J. H. Kempster, formerly Chief Chemist at Buffington, has been appointed Superintendent of Mills Nos. 3 and 4 there. Mr. M. S. Humphreys, formerly Chief Draftsman, has been appointed Superintendent of Mill No. 6.

The Erie R.R. announces the following changes in its operating force: Mr. Samuel C. Stickney, formerly Assistant General Manager at New York City, has been appointed Assistant to the Vice-President of the Erie, the Chicago & Erie, the New York, Susquehanna & Western and the New Jersey & New York railroads. Mr. Jason C. Tucker, Assistant to the General Manager at New York, has been appointed Assistant to the Vice-President. Mr. John D. Cummin, Assistant to the General Manager at New York, has been appointed Assistant to the Vice-President. Mr. Frederick B. Lincoln, formerly General Superintendent of the Erie R.R. and subsidiary lines east of Salamanca, has been appointed General Manager of the Lines East of Buffalo and Salamanca, with headquarters at New York City. Mr. William A. Baldwin, formerly Assistant General Superintendent at New York City, has been appointed General Superintendent of Lines East of Buffalo and Salamanca. Mr. John B. Dickson, formerly Assistant General Manager at Cleveland, has been appointed General Superintendent of Lines West of Buffalo and Salamanca. Mr. George W. Kirtley, formerly Superintendent of Transportation at New York City, has been appointed General Superintendent of Transportation.

OBITUARY

E. P. Lord, Secretary of the G. H. Williams Co., of Erie, Penn., manufacturer of derricks and clamshell buckets, died recently.

Col. Alexander S. Merritt, who for many years was connected with the Department of Water Supply, Gas and Electricity of New York City, died in Brooklyn, N. Y., on June 6.

Abel T. Barnes, who for more than 35 years served as Consulting Engineer of the B. F. Sturtevant Co., of Boston, died at his home in Sharm, Mass., on June 10, in his 80th year. He retired from active work only last September.

William L. Rutan, formerly Inspector of Buildings of Sacramento, Calif., died recently in that city. Mr. Rutan was born in Newark, N. J., about 50 years ago. For many years he lived in Boston, Mass., where he was connected with the Norcross Bros. Co., and subsequently, in partnership with Mr. John Fraser, conducted a contracting and building business. He is survived by a widow and daughter.

Capt. Thomas Johnson, formerly of Wilmington, Del., died at his home in Belle Haven, Va., on June 6, at 87 years of age. Captain Johnson entered the Harlan & Hollingsworth Co. at the age of 22, and in 1894 retired as Superintendent of the shipyard of the company. His last work before retiring was superintending the construction of vessels for the Baltimore, Chesapeake & Atlantic Ry. His widow and a family survive him.

Charles E. Chinnock, a pioneer in the electric light and telephone fields, died recently at his home in Brooklyn, N. Y. Mr. Chinnock was born in London, England, about 70 years ago. He started his career in this country as a telegrapher, and later was associated with Thomas A. Edison. He was subsequently the superintendent of the first central station of the New York Edison Co., and as Vice-President of the Edison United Manufacturing Co. was largely responsible for the founding of the Edison Electric Illuminating Co. of Brooklyn. At one time he was Chief Electrician of the Metropolitan Telephone Co., now the New York Telephone Co. Mr. Chinnock was the inventor of numerous electrical devices, among them an automatic transmitter for teaching telegraphy, which was adopted by the United States Government, and a method of suspending aërial cables, now used by all the telephone and telegraph companies. He is survived by a widow, a son and a daughter.

ENGINEERING SOCIETIES

COMING MEETINGS

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 22-25. Annual meeting at Iowa State College, Ames, Iowa. Secy., F. L. Bishop, University of Pittsburgh, Pittsburgh, Penn.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 22-25. Summer meeting at Buffalo, N. Y. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 22-26. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Aug. 16-18 and 25-28. Annual meeting in Los Angeles, Calif., Aug. 16-18; in San Francisco, Aug. 25-28. Secy., J. C. Olsen, Cooper Union, New York City.

AMERICAN ASSOCIATION OF RAILROAD SUPERINTENDENTS.
Aug. 19-21. Annual convention in San Francisco. Secy., E. H. Harman, Room 101, Union Station, St. Louis, Mo.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 16-18. Annual meeting in San Francisco. Secy., Chas. Warren Hunt, 220 W. 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Sept. 16-18. Annual meeting in San Francisco. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Sept. 16-18. Annual meeting in San Francisco. Secy., Bradley Stoughton, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Sept. 16-18. Annual meeting in San Francisco. Secy., F. L. Hutchinson, 29 W. 39th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Sept. 16-18. Annual meeting in San Francisco. Secy., J. J. Blackmore, 29 W. 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 16-18. Annual meeting in San Francisco. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

INTERNATIONAL ENGINEERING CONGRESS.
Sept. 20-25. In San Francisco.

The New England Water Works Association is to hold its next annual meeting in New York City, Sept. 7 to 9. The headquarters will be at the Waldorf-Astoria Hotel.

The Cleveland Engineering Society—The 35th annual banquet was held at the Hotel Statler on June 8. About 300 members and guests attended. Among the speakers were Hon. Newton D. Baker, Mayor of Cleveland; David Bell, president of the Engineering Society of Buffalo, and C. H. Esselstyn, past-president of the Detroit Engineering Society.

American Railway Master Mechanics' Association—At the annual convention of the Master Mechanics' Association, held last week in Atlantic City, N. J., the following officers were elected: President, E. W. Pratt (C. & N. W.); first vice-president, William Schlafge (Erie); second vice-president, F. H. Clark (B. & O.); third vice-president, W. J. Tollerton (C., R. I. & P.); treasurer, Angus Sinclair. Oscar F. Ostby was elected president of the Railway Supply Manufacturers' Association.

National Paving Brick Manufacturers' Association—The Board of Directors at its quarterly meeting, held in Cleveland, May 27, affirmed arrangements tentatively made for holding the annual meeting at Dayton, Ohio, Oct. 11 to 12. In this same week the American Society of Municipal Improvements holds its annual meeting at Dayton. The assistant secretary of the paving association is H. H. Macdonald, 830 Brotherhood of Locomotive Engineers Building, Cleveland, Ohio.

River Terminal Association—At the meeting of the newly organized River Terminal Association in Kansas City, Mo., the following officers were elected: President, A. O. Eberhart; vice-presidents, Irving C. Norwood, J. F. Smith, J. W. Fall, Walter S. Dickey and J. H. Rosenberger; secretary, C. F. Perry, Quincy, Ill. The program for the ensuing year agreed upon by the organizers includes a canvass of the river-terminal possibilities of every river town in the Mississippi Valley.

The Railway Real Estate Association—This association has just been organized; its membership will comprise, it is hoped, all the railway officers of America, Canada, Mexico and Cuba who are directly concerned with the various activities pertaining to the lands of their respective corporations. Provision is made for the formation of sections, such as Track Division, Agricultural Division, Right-of-Way Division, etc. The first meeting is scheduled to be held in Chicago, Ill., Oct. 13, 1915. The officers are: President, F. P. Crandon, C. & N. W. Ry.; first vice-president, J. D. McCubbin, B. & O. R.R.; second vice-president, B. A. McAllaster, Southern Pacific Lines; secretary, Frank C. Irvine, Pennsylvania Lines; treasurer, James G. Armstrong, W.-P. T. Ry.

American Institute of Electrical Engineers—The program for the thirty-second annual convention, at Deer Park, Md., has been announced. In addition to a number of papers of great interest to specialists in electrical machine design, there are many of broader engineering interest. The following list should be noted:

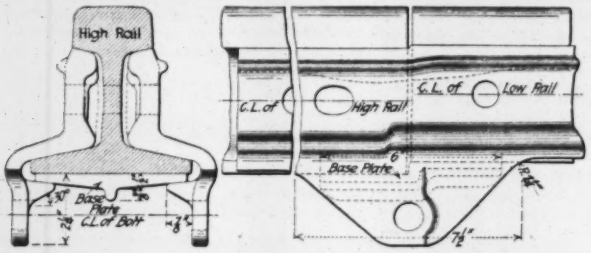
"The Electric Strength of Air," by J. B. Whitehead; "Foundations for Transmission-Line Towers and Tower Erection," by J. A. Walls, J. B. Leeper, W. E. Mitchell, P. M. Downing and F. C. Connery; "Fields of Motor Application," by D. B. Rushmore; "Electricity in Grain Elevators," by H. E. Stafford; "Effective Illumination of Streets," by P. S. Millar; "Systems of Street Illumination," by C. P. Steinmetz; "Construction and Maintenance of Overhead (Railway) Contact Systems," by E. J. Amberg and F. Zogbaum; "Contact System of the Butte, Anaconda & Pacific Ry.," by J. B. Cox; "Third Rail and Trolley System of the West Jersey & Seashore R.R.," by J. V. B. Duer; "Unprotected Top-Contact Rail for 600-Volt Traction System," by C. H. Jones; "Contact Conductors and Collectors for Electric Railways," by C. J. Hixson; "Contact System of the Southern Pacific Co.," by P. Lebenbaum; "Economic Operation of Electric Ovens," by P. C. Gumaer; "Class Rates for Electric Light and Power Systems or Territories," by F. G. Baum.

Appliances and Materials

Cast-Steel Compromise Rail-Joint

The compromise joint shown herewith, for connecting rails of different sections, is of the type in which the base support is reinforced by a bolt beneath the rails. The splice-bars are of heat-treated cast steel (of over 78,000 lb. tensile strength) made in any desired length, for four or six bolts, and with the opposite ends made to fit the particular rail sections which are to be spliced. Lateral stiffness of the

bars at the joint is secured by a horizontal rib near the top, this rib tapering off toward the ends. The depressed portions of the bars are formed with ribs on their inner faces to support the sides of a base-plate which is stepped to fit the rails. The contact surfaces are slightly inclined, so that on tightening the one bottom bolt the splice-bars give a tight grip



READING CAST-STEEL COMPROMISE JOINT

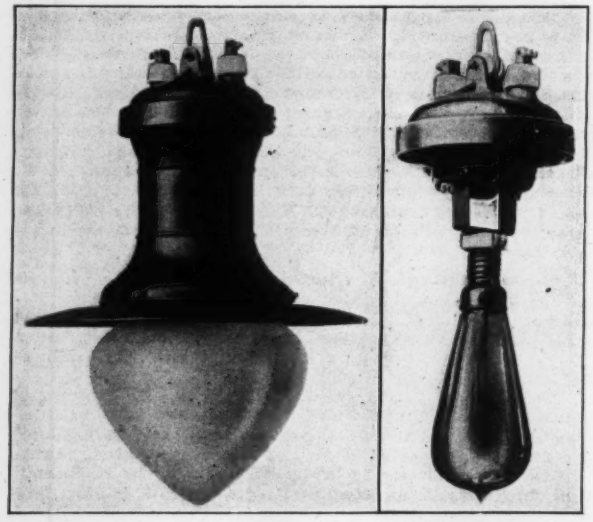
upon the top and bottom faces of the rail flanges, thus holding the rails securely against vertical motion.

These joints are being employed by several railways, especially at terminals and interlocking points and are made by the Reading Specialties Co., Reading, Penn.

* * *

Tungsten-Lamp Street Fixtures

The development of high-power tungsten lamps with gas-filled globes and the demand for using these efficient light sources in street lighting have required the design of new fixtures, one type of which (that of the Westinghouse Electric & Manufacturing Co., of Pittsburgh) is shown in the accompanying view. The heat radiation from these lamps is comparatively intense, so that ventilation, protection from



TUNGSTEN-LAMP STREET FIXTURES

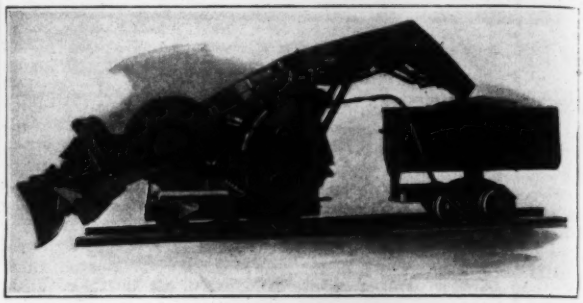
rain and snow, etc., have been fully provided for. The globe is preferably of diffusing glass because of the great brilliancy of the light. The casing has a small auto-transformer, so that the most efficient 15- and 20-amp. lamps can be used on 6.6- and 7.5-amp. street circuits. The transformer also replaces the automatic cutout (for lamps out of commission), since it is designed to stand continuous operation with an open-circuited secondary.

* * *

Underground Shoveling Machine

The shoveling machine shown in the accompanying illustration was first demonstrated by the Lake Shore Engine Works last fall. The demonstration unit is now in service at Alpha, Mich., loading 2-ton cars in an 8x8 drift. The time taken is from 1½ to 4 min., with 3 min. as an average. This is to be compared with 20 min. by hand. The total cost is 3.1c. per ton, compared with 10.2c. for hand labor.

The machine is in three unit sections—(1) the top, containing all working parts for the conveyor and shovel; (2) the center, containing all the motive power, clutches and driving gears; (3) the truck. The top can be lifted off the center section after removing two side-frame caps and the center can immediately be lifted from the truck. The machine,



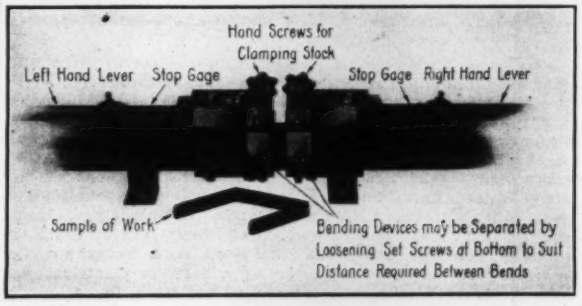
HALBY SHOVELING MACHINE

ready for operation, is 15 ft. in overall length, but it can be shortened to 10 ft. for limited space, curves, etc. The overall height is 5 ft. 4 in., and the width 4 ft. The weight is 7500 lb.

* * *

Adjustable Reinforcement Bender

A new reinforcing-bar bender, shown in the accompanying view and known as Wallace No. 1 double-lever bar bender, is now manufactured by the Wallace Supplies Manufacturing Co., 412 Orleans St., Chicago. The machine is adjustable for making two bends (right-hand and left-hand) with-


Hand Screws for Clamping Stock
Left Hand Lever
Stop Gage
Stop Gage
Right Hand Lever
Sample of Work
Bending Devices may be Separated by Loosening Set Screws at Bottom to Suit Distance Required Between Bends

WALLACE BAR BENDER

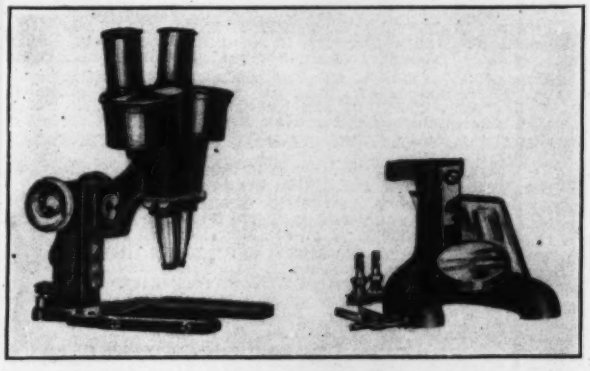
out resetting the bending device or without intermediate removal of the bar being bent.

It is further provided with hand-screws for clamping the bar into place to prevent slipping and to insure accuracy of bending. Guides are provided for bending round, square or flat bars, and particularly for bending flat bars edgewise. The device is arranged so as to be clamped to a work bench.

* * *

Binocular Microscope

A prismatic binocular microscope is being made by the Bausch & Lomb Optical Co., Rochester, N. Y., affording a magnified image equivalent to an enlarged model of a specimen seen with two unaided eyes. Perspective, depth perception, form and solidity are preserved with an erect and un-



BINOCULAR MICROSCOPE AND STAND

reversed image. The accompanying illustration shows the instrument detached from its base for the examination of large surfaces. The entire arm and body tube can be removed for use on a large stand with bulky specimens. The instrument, with one pair each of eyepieces and objectives, sells for $60.